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Vol. XII MARCH, 1907 No. 1

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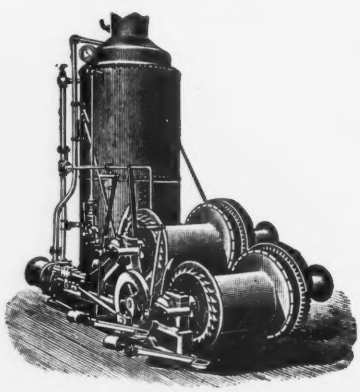

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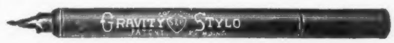

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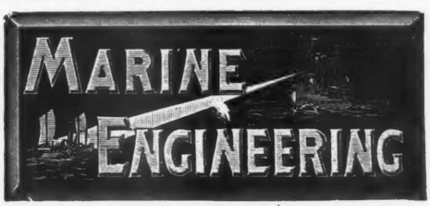

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CONTENTS.

FOUNDATION PROBLEMS IN NEW YORK CITY

C. M. Ripley.

Preventing Collapse of Neighboring Buildings. Caissons Sunk to Bed-Rock by Pneumatic Process; Latest Method With Moran Air Lock.

The gigantic increase in the erection of skyscrapers in the "Lower Broadway" section of New York City during the past few years, has been made in the face of grave and increasing engineering difficulties. A study of the laying

FIG. I.

of the foundations for the Trust Company of America (see Fig. No. 1), now nearing com-

pletion in the financial section of Wall Street, will bring out forcefully: (1) What these problems are, and (2) how the talent of engineering contractors has been developed. Less than a dozen years ago the following conditions would have been considered *insurmountable obstacles* making impossible the construction of a twenty-five story building on this site.

As shown in the accompanying plan (Fig. No. 2) this building is situated between the present United States Trust Company and the Mills buildings. Owing to the prevailing prices of Wall Street real estate, every inch of available space had to be utilized, with the result that the foundations of the new building practically "rub elbows" on either side with those of the old.

GEOLOGICAL DIFFICULTIES.

It is not generally understood that as we approach the southern end of Manhattan Island, the bed-rock slopes off lower and lower below the surface, so much so that at Wall Street it is 80 feet below the curb and at the Battery between 90 and 100 feet below. It might be mentioned in this connection that the rock appears at water line at about 14th street, and continues rising as we approach upper Manhattan, so that in building projects in this latter portion of the city, it is often necessary to blast away a miniature mountain before the site is even down to street level. It is due to this characteristic of New York's geological formation that the excavation for the great Pennsylvania Railroad depot has so often been termed a veritable "quarry." In

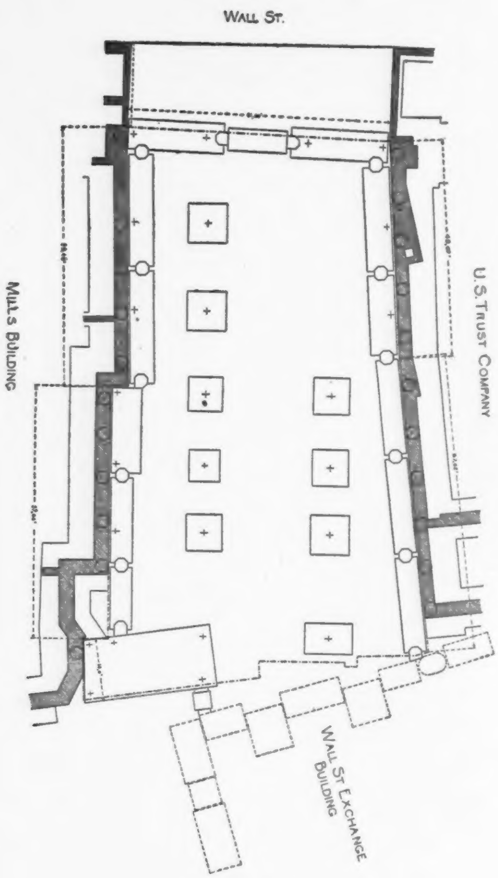


FIG. 2.

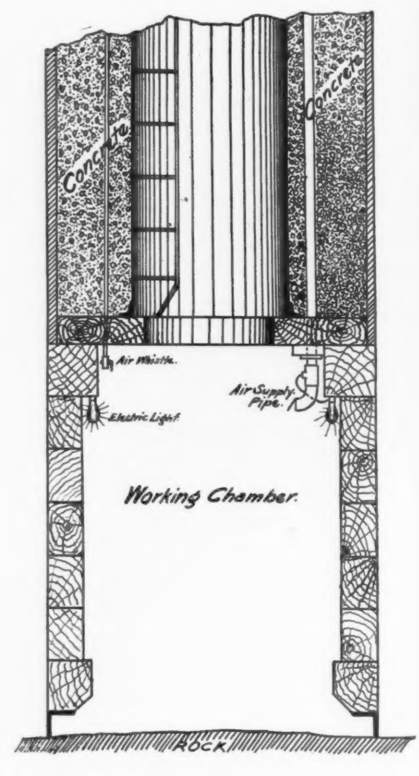


FIG. 3.

these cases the foundations are supplied by nature.

A STRIKING CONTRAST.

In striking contrast to such simple foundation problems, we have the case at hand. Foundations to be laid to bed-rock, through about 80 feet of quicksand and water-bearing strata which is already heavily loaded by adjoining ten-story buildings. In digging, water and soft mud is encountered but a few feet below the street level, and were this soft muck pumped out or removed by any of the old-time methods, more of this fluid material would enter the excavation from either side and the adjoining structures would settle and later collapse. The Foundation Company, to whom was entrusted the responsibility both the water line was struck. Then a six-foot length of riveted steel pipe, 36 inches in diameter, was jacked down into the sand, thereby employing the weight of the building in constructing the new underpinning. A downward opening door was installed at the top of this length, a second length was bolted to the first, and then a second downward opening door was installed, completing the miniature air-lock. As shown in Fig 5, compressed air was supplied to the bottom chamber and the work pushed lower and lower through quicksand or hard pan, as successive lengths of pipe were bolted to the top, and material excavated. When rock was reached the entire cylinder was filled with concrete, the steel pipe remained, and when the steel beams were placed,

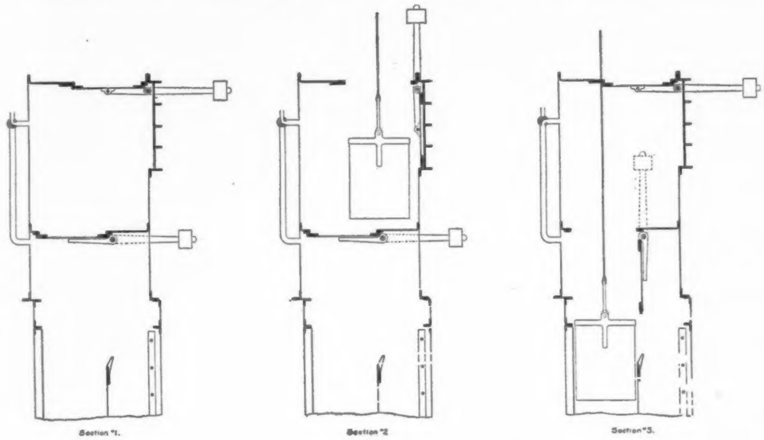


FIG. 4.

of planning and doing this work, solved these problems by employing the Pneumatic Caisson Process, in conjunction with the Moran Air-Lock, an invention of their vice-president, Mr. Daniel E. Moran, C. E.

UNDERPINNING ADJOINING BUILDINGS.

The principle of the air-lock was used for the underpinning of the adjoining buildings as well as for the main part of the work. Cut No. 5 shows how work was begun even while the old building was being wrecked. Niches about five feet above the cellar floor, and five feet wide, were cut in the walls of the adjoining buildings with Box electric and Ingersoll-Sargent steam drills at intervals of about every six to nine feet. These were carried downward, through the old foundation, and through the sand under the foundation until as shown in the left side of Fig. 5, the underpinning at that point was completed. Twelve of these concrete cylinders support the wall of the Mills Building, and eleven that of the United States Trust Company Building, as shown by the circles in the shaded portion of Fig No. 2.

Twenty-seven concrete piers constitute the foundation work proper, under the Trust Company of America Building. The remarkable speed with which these piers were sunk to bed-rock was made possible mainly from this one fact: The Moran air-lock allows the material excavated in caisson to be hoisted to the open air in one continuous haul, being handled but once in transferring from bottom caisson up to the dumping place, generally a truck. This feat was never possible with any

other equipment until Mr. Moran took the lead and perfected his device shown in Fig. No. 4.

The square and rectangular spaces shown in Fig. No. 2 give the location of the concrete piers on the site of the Trust Company of America Building. In Fig. No. 6 is shown the four-boom traveler derrick, which is equipped with four double-drum Lidgerwood hoisting engines, and which effectively covered the entire area. It served to place the caissons (one of which weighed 20 tons and was 14x31x8 feet high) at their proper location. It also hoisted men and material in and out of the 27 working chambers. A typical caisson or working chamber is shown in Fig. No. 3.

Figure No. 6 shows the Moran air-lock in place near the top of the picture. The man stooping down on the ground is the gauge tender who keeps the pressure steady for the convenience of the men in the working chamber and the man at the air-lock communicates signals between the excavators and the engineers.

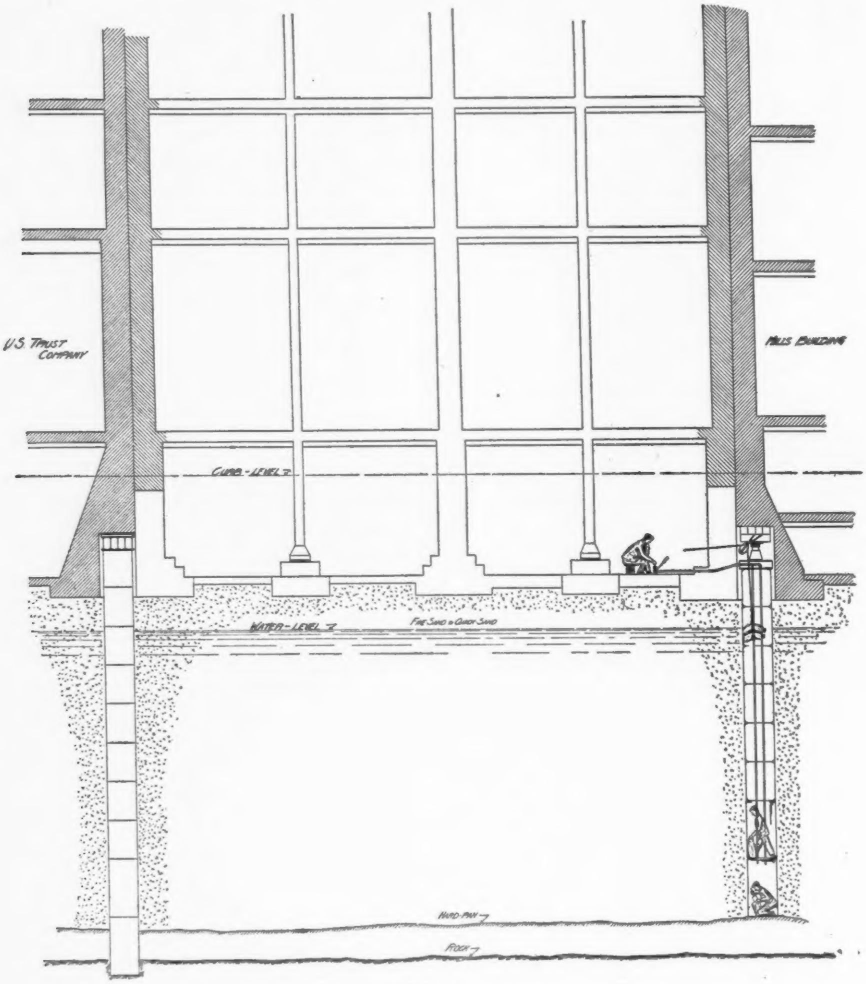


FIG. 5.

THE METHOD.

Having a general knowledge of the difficulties and of the apparatus to be used, and having finished the description of the under-

pinning, we shall take up the method employed in sinking the 27 great concrete piers through this soft soil to bed-rock without weakening the adjoining foundations. See Fig. No. 6.

After the wooden caisson proper had been located accurately, the workmen with picks and shovéls excavated inside the open topped was joined to the upper part of the caisson as shown in Fig. No. 3. Section after section were added and then a Moran Air Lock as shown in Fig. No. 6. Then a section of temporary wooden cofferdam was built and fitted to the outside of the caisson so as to extend its sides upward several feet This was to act as

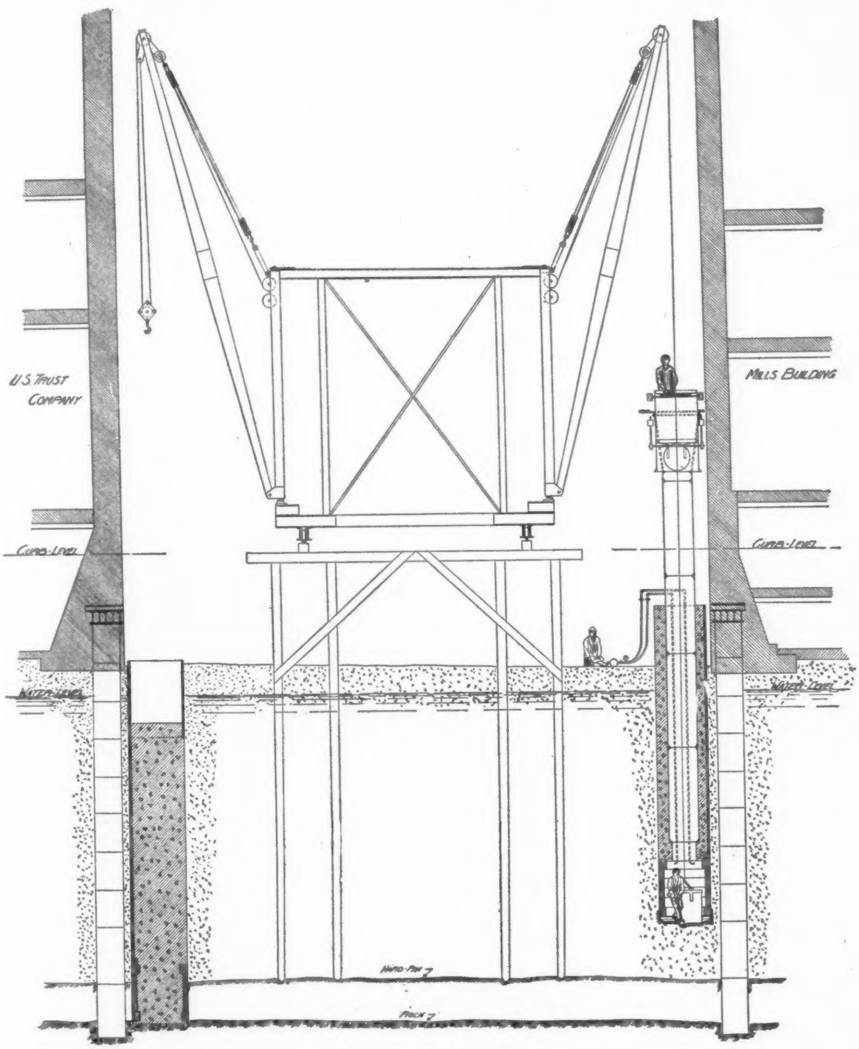


FIG. 6.

frame, which gradually sank of its own weight. When it had sunk to water level, which was but four to five feet below the street, preparations were made to apply the compressed air as follows: The open top of the caisson was roofed over temporarily and the first ten-foot section of the steel collapsible working shaft a false work for retaining the successive thin layers of concrete dumped into the annular space inside the cofferdam and on the roof of the caisson surrounding the working shaft, as will be noticed in the right hand side of section in Fig. No. 6. After the first ten feet of concrete had hardened, a second cofferdam

was fitted in a higher position, and the concreting continued, the first cofferdam being later removed and used as the third. One gang of men and one mixer could move from cofferdam to cofferdam, applying a two-foot layer in each, so that by the time they returned to the first one it was hardened enough to receive its next layer without distorting the sheeting. So nearly the full height and full weight of the finished pier was used to force the caisson down to its final resting place on bed-rock, as rapidly as the excavating could be done by the men inside. Alpha Portland cement was used on this job in a 1 to 2½ to 5 mixture.

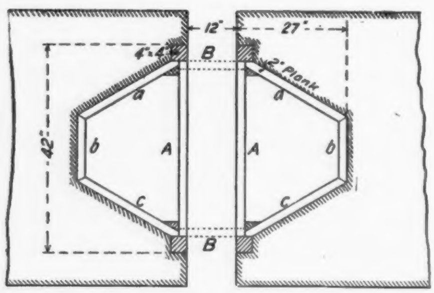


FIG. 7.

Referring again to Fig. No. 3, it will be noticed that the lower edges of the caisson sides are sharpened to form the "cutting edge" of the caisson, since they follow the level of the excavation and are pressed down by the great weight above. The contracting firm have prepared special two-ton C. I. weights, which can be piled on top of the concrete pier to further sink it in case the "skin friction" on the sides is too great for the pier to sink of its own weight.

During this process three eight-hour shifts of the laborers were digging out material in the caisson under a pressure of from 18 to 24 pounds per square inch. This material was shoveled into buckets and hoisted up through the working shaft and the air-lock out to the atmosphere, all in one continuous lift as previously explained in connection with Fig. No. 4.

FILLING IN THE CONCRETE PIERS.

When bed-rock is reached, it is leveled off and, still under compressed air, the concrete is lowered into the caisson and rammed in place. The entire caisson is filled to the top, the temporary roof removed, and as the men retreat up the tube they unbolt and remove a section of the collapsible tubing and hoist it up for use in sinking another caisson. Gradually the entire space previously used as a passage for men and material in and out of the working chamber or caisson, is filled with concrete, thus making the pier one solid monolith of concrete from bed-rock to the column base. This is shown on the left side of Fig. No. 6.

Referring again to plan view, Fig. No. 2, it is seen that these piers are sunk end to end with only 12 spaces between, and that the chain of piers around the entire site is made perfect by *welding or bonding* between the ends of each pier. This keeps the water from the surrounding soil from entering either the basement or sub-basement of the building. The method is as follows: In Fig. No. 7 will be seen the end faces of the two adjacent piers. The semi-octagonal grove shown in the faces was formed at the same time that the cofferdam was put around the top of the caisson. The wooden false work served as a "core," displacing the concrete from top to bottom of each end face of the piers. As soon as two adjacent caissons were ready to be welded or bonded the space bounded by ABAB was excavated. At the same time the laborers would tear off the boards AA, saw them into the shorter lengths BB, and nail them in position BB, as shown in dotted lines. The space between the piers thus had become octagonal in shape and was carried down the few feet to the water level. The planks abc abc were removed. A four-foot length of steel cylinder 30 inches in diameter was placed in the opening and the space between it and the surrounding concrete and boards BB, was filled in with concrete and made air tight. An air-lock was bolted to the top of this cylinder and the workmen excavated the material between A and B, tearing out all the lumber as they went down, and hoisting all the material to the surface except what was needed for completing the boards BB down to the top of the caisson. This octagonal well was then filled to the top with concrete under pressure and the bond was complete. When these connections between piers were completed on the north, east and west borders of the building site, it was only necessary to make the bond

with the foundation piers of the Wall Street Exchange building on the south (put in by the same contractor to bed-rock) in order to fully enclose the lot and prevent future flooding of the cellars, which reach to a depth of near 40 feet below the water level. It will be seen from Fig. No. 2 that this was done without expense of sinking a separate line of caisson on that side.

Another advantage in this *solid wall* type of bonded foundation construction, is that the piers in the center of the lot can generally be sunk without the expense of the compressed air method, for there is little danger of any water seeping in from the outside, and therefore of weakening the other buildings.

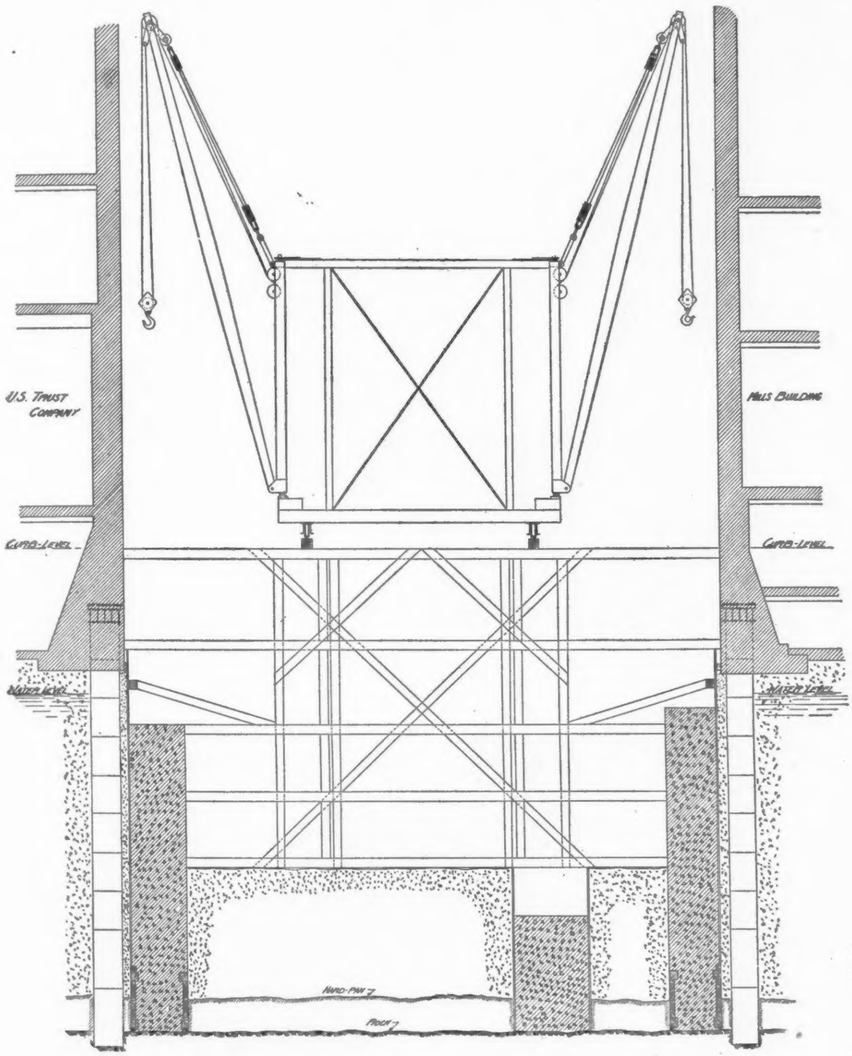


FIG. 8.

At this stage of the job, the cellars can be safely dug, during which work the shoring of the neighboring building walls is shown in Fig. No. 8. Fig. No. 9 illustrates the ap-

pearance when all the substructure is completed and the cellar made ready for installing engines and boiler. The general class of work of which this job is merely one branch, is *Civil Engineering in water or water-bearing strata,* including mine shafts in wet or marshy lands, bridge piers, sea walls and tunnels. The Foundation Company, of 35 Nassau Street, New York, were the contractors for the work described above.

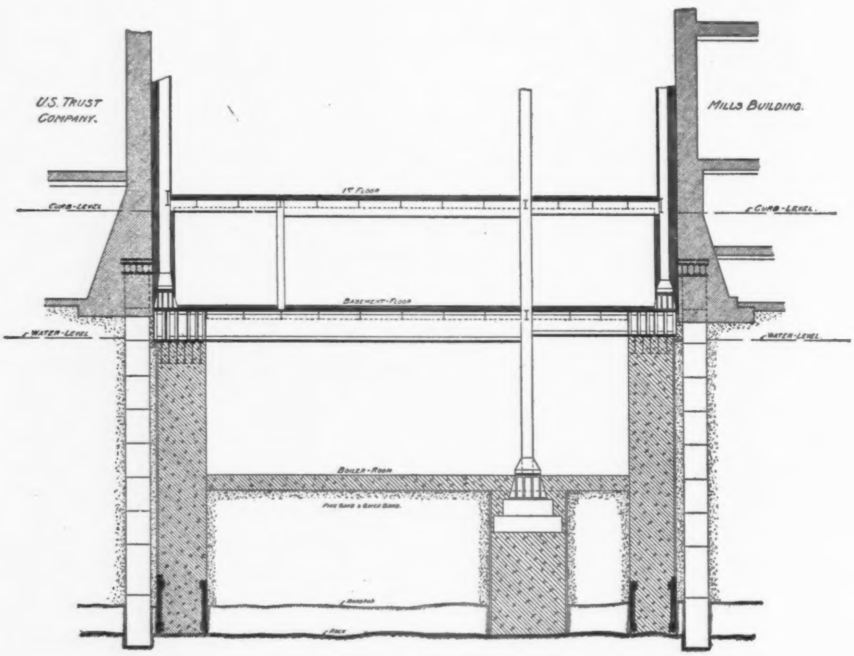


FIG. 9.

POWER prices vary widely. As a rule, power from hydraulic installations is cheapest, and power developed from coal that must bear the expense of a long railroad haul is the dearest. According to a recent report by the Hydro-Electric Power Commission appointed by the Ontario Government $12 per horse-power year may be assumed as the cost of developing high-tension power at Niagara Falls. Transformed into low-tension power and delivered to sub-stations throughout the province, the cost would be from $15 to $35, varying with the amount, distance and load. The cost of distribution from the substations to the individual consumers would vary from $2.51 to $24.74 per H. P. year, according to the amount and the distance. The annual cost of twenty-four-hour steam plant power per brake horse-power, with $4 bituminous coal, according to the same report, would vary, with the character of the plant and the amount of power developed from $41.11 to $180.76. Under the same conditions, it is estimated in this report that producer gas power would vary in cost from $34.66 to $90.02. For ten-hour power, developed from producer gas, the cost would vary from $20.46 to $53.48; for steam-power from $22.47 to $91.16.

TRAVELERS have noted that Damascus blades are made only when the wind is from the north. The experiments of M. Anozoff were suggested by this hint, and have consisted in hardening steel instruments by cooling them in a powerful current of compressed air instead of quenching in water. The trials indicate that for very sharp tools this method is superior to any other. The effect varies with the thickness of the mass to be hardened, and increases with the coldness of the air and the rapidity of the stream.

SOME IMPORTANT ELEMENTS OF ECONOMY IN THE STRAIGHT LINE AND DUPLEX TYPES OF COMPOUND AIR COMPRESSORS*

By Lucius I. Wightman.

The act of compressing air in any of the usual types of air compressors, and of expelling the air from the compressor cylinder at the pressure desired, throws a constantly varying resistance upon the compressor piston. At the beginning of the stroke, the cylinder being filled with air certainly not above atmospheric pressure, the resistance to the advance of the piston is zero. The pressure, however, begins to rise at once and the corresponding resistance against the piston increases, and in an increasing ratio, until nearly the end of the stroke when the required pressure is reached, and the remaining distance is traversed by the piston against a practically uniform maximum pressure. Upon the return stroke, the compressor cylinder being donble-acting, the resistance is again zero at the beginning of the stroke and maximum for the latter part of it.

ADVANTAGES OF STEAM COMPOUNDING

The advantages of compounding in steam engine practice everywhere are so familiar as to require not even a repetition here, but its special value in air compressing practice seems not to be fully appreciated. In view of the number of steam-driven compressors in use which are neither compounded nor condensing, it seems that it is not generally understood that, while a saving of 10 to 15 per cent of the power cost is possible at the air end of the compressor by compounding, a saving of about double that percentage in fuel cost—20 to 30 per cent—is easily possible by compounding the steam end of the same machine. If compound compression is economically practical, why neglect a saving twice as great possible by compound steam expansion?

THE PECULIARITIES OF COMPRESSOR OPERATION

This neglect is especially remarkable in view of the fact that the air compressor embodies load conditions which make the compounding and condensing of steam cylinders even more economically desirable than in general steam engine practice. Compound steam-driven air compressors can show better results than compound stationary engines for power purposes, and for a very simple reason. To get all the economy possible from the steam, it must be admitted to the first cylinder in just such quantity that when it is finally expanded into the low pressure cylinder, its pressure there shall be such as to avoid excessive expansion and consequent heavy condensation losses. This means, of course, the admission of the same quantity of steam per stroke, for each stroke, implying a cut-off constantly fixed very close to the right point. This is entirely impossible with the stationary engine, where the constant speed under varying load must be maintained by a constantly changing cut-off, this cut-off being automatically controlled by the governor, and necessarily having a wide range to meet load conditions. There can be only one *best* point of cut-off, and departures from that necessarily impair the ultimate economy.

THE LOAD PER STROKE CONSTANT IN THE COMPRESSOR

In the case of the air compressor the load is constant per stroke, for the same delivery pressure must be maintained; and the cylinders can be so proportioned and the cut-off so set as to secure and maintain the best results. The governing variations of the steam-driven compressor are as to speed only, and, with air pressure constant, the changes in speed are made either by a very slight change of cut-off, or with a throttling governor. In the latter case the slight "wire drawing" is about offset by the resultant superheating of the steam. As a result of these conditions the compound compressor can be made to work close to its best economy at all times.

STEAM PRESSURES FOR COMPOUND COMPRESSOR CYLINDERS

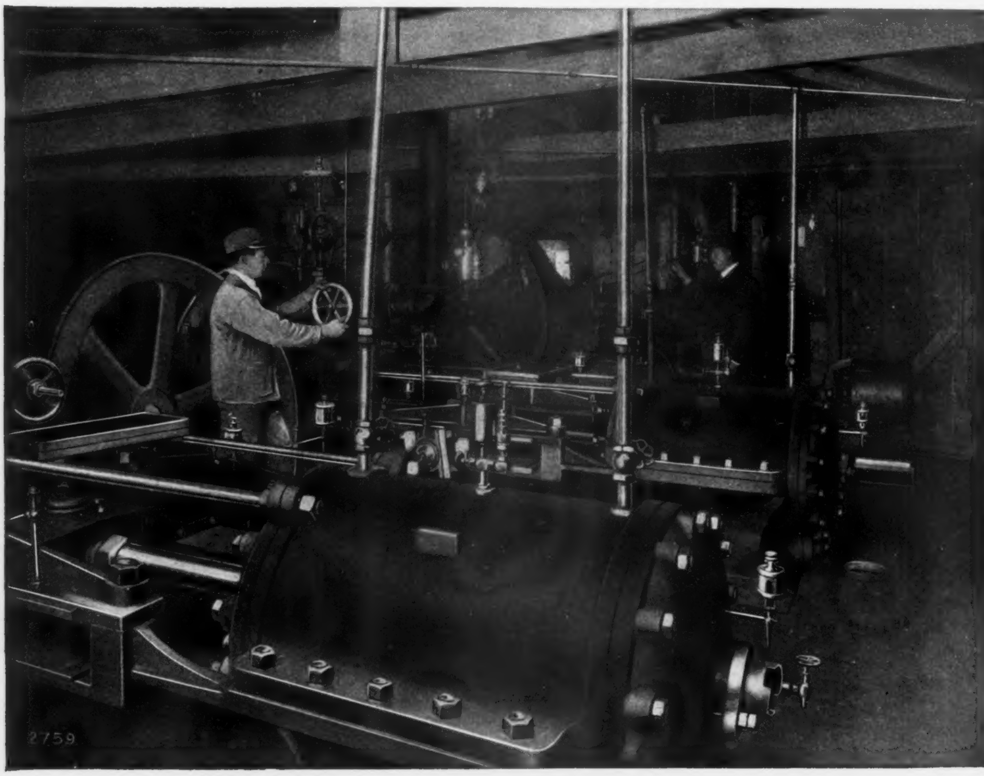
The steam pressure used has an important bearing upon the ultimate economy. Within practical limits, the higher the pressure, the better the results. Gauge pressures of 125 to 150 pounds are now quite common in new installations; but, in air compressor practice, steam compounding is advantageous with steam at 80 pounds condensing, or 90 pounds non-condensing, though this may not be at all true in general power practice. When, as is often the case where compressors are used, water is costly, the smaller amount required by the compound is an argument for it; and the ultimate cost of the arrangement is also largely offset by the reduced cost of boiler installation

Illustrations reproduced by courtesy of the Ingersoll-Rand Company of New York.

and operation, due to the lower steam consumption.

STRAIGHT LINE AND DUPLEX COMPRESSORS

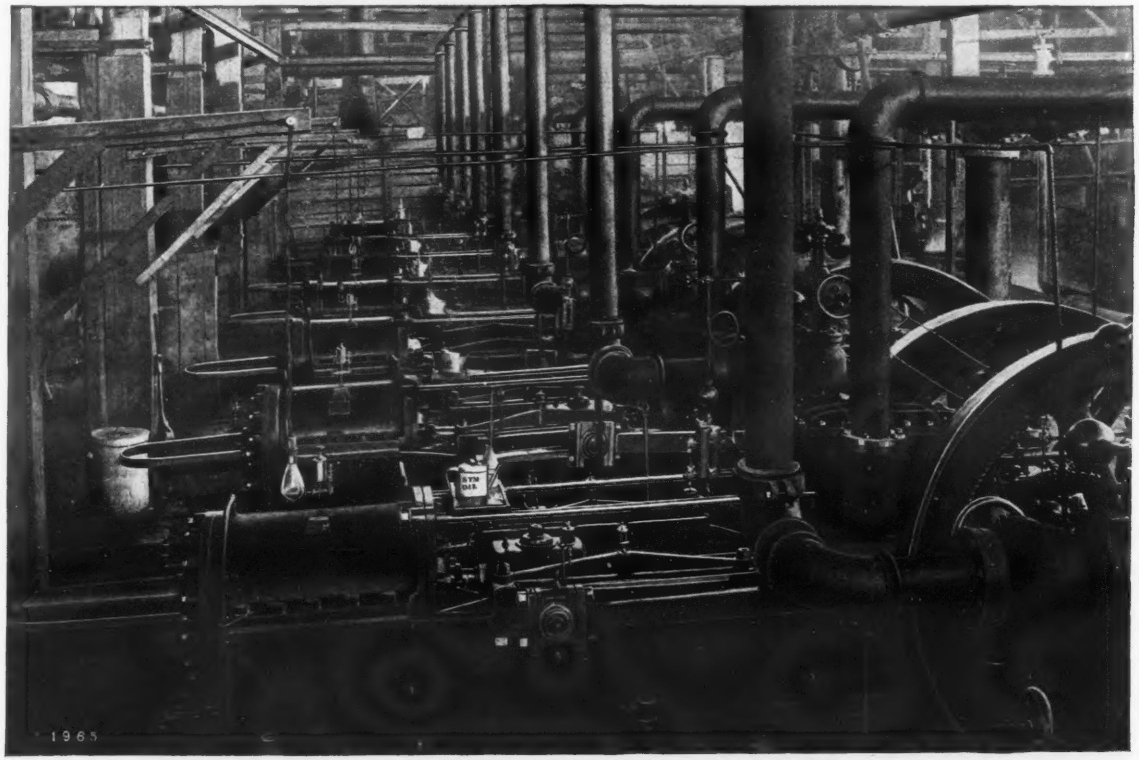
It is unnecessary at this point to enter into a discussion of the phenomena of the application of power to resistance in the present work. It will be enough to mention and to briefly draw the distinction between the two standard types of air compressors, designated as the straight line and duplex. In the former, steam and air cylinders, whether simple or compounded, are arranged in a straight line, and power is applied to resistance through the medium of one long piston rod. In the duplex machine there are two elements, set side by side, each made up of a steam and an air cylinder, and each element in effect a straight line machine. However, the cranks of these two sections are set at an angle of 90 degrees, or one-fourth part of a circle, on the shaft. The primary object of this quartering crank arrangement is to secure a more uniform rotation effect, and to improve the regulation qualities of the machine by making it easier to run at slow speeds through the mutual assistance of the two sides. The straight line compressor may have two three, or four cylinders, but they must all be arranged in a straight line or "tandem" to one another. The duplex compressor must have four cylinders.



A TYPICAL "STRAIGHT LINE" INSTALLATION.
Two single stage machines used in driving the Lookout Mountain Tunnel of the Southern Railway, Tennessee.
Steam cylinders, 20 inches; air cylinders, 22¼ inches; stroke, 24 inches.

THE RELATION OF POWER TO RESISTANCE IN STRAIGHT LINE COMPRESSORS

This distribution of resistances in the act of compression in the air cylinder is precisely the reverse of the development of the power in the steam cylinder. There the pressure is maximum at the beginning of the stroke and practically uniform until cut-off occurs and then the pressure rapidly falls all the way to the end; so that in any compressor of the straight line type the steam power is in excess of the



A LARGE "STRAIGHT LINE" COMPRESSOR INSTALLATION FOR A CONTRACTOR'S PLANT.

An installation of eight 24-inch stroke machines in the power house of H. S. Kerbaugh, Inc., at Safe Harbor, Pa., used in building the low grade "cut-off" of the Pennsylvania Railroad along the Susquehanna. This is the largest railway contract ever handled by compressed air from a central plant, the work covering 9 miles of solid rock cut and employing 250 rock drills and 42 well drilling machines operated by compressed air.

work to be done at the beginning of the stroke in either direction and inadequate to overcome the resistance of the air at the other end of the stroke, except with the assistance of flywheels.

The pistons, by means of the crosshead and connecting rods, act through the crank upon the rotation of the flywheel, the excess of pressure causing the wheels to acquire momentum at the beginning of the stroke and to give off this acquired momentum at the end of the stroke in overcoming the excess of the air piston resistance. As soon as the crank passes the center, the machine again feels the impulse of the full pressure of steam, with no load at first to take up this power in the air end.

HOW THE DUPLEX COMPRESSOR MEETS THESE CONDITIONS

Attention is now called to the duplex compressor, in which the operating conditions are in decided contrast to those just sketched, and in which the most objectionable of the conditions are minimized or altogether eliminated, and various points of practical advantage are secured instead.

A duplex air compressor, as already stated, is, in essential effect, a combination of two straight line machines so far as the steam and the air cylinders are concerned, with a single crank shaft and a flywheel in the middle of it serving for both, there being a single connecting rod for each side and a single crank on each end of the shaft.

THE ADVANTAGE OF QUARTERING CRANKS

The first special feature of advantage of the duplex machine is in the arrangement of the cranks in relation to each other upon the ends of the shaft. These are set with one of the cranks a quarter of a circle in advance of the other, the result of which is to so time the movements of the pistons on the two sides of the machine that one will be at nearly midstroke when the other is at the beginning or the end of its stroke. The two sides thus alternately help each other over the hard places, and, while not under nearly as great obligation to the flywheel, their action is much steadier and so free from excesses of pressure over resistance, or of resistance over pressure, that the rotation is more uniform. The practical limit of speed is lowered to perhaps one-quarter of what it was before, so that, if the cut-off on the steam cylinder is properly set, the machine may be made to automatically stop and start itself and to run at any speed down to the lowest, as the air consumption may require. All waste of power and all wear of parts consequent upon keeping running above "centering point" when not delivering any air, will be entirely avoided.

THE RELATION OF POWER TO RESISTANCE IN THE DUPLEX

Suppose that one of these duplex compressors is in regular operation, with the pistons on one side—say the near side— just beginning their stroke, and with the great excess of pressure behind the steam piston, and the very low resistance before the air piston as we have described the situation in the straight line machine. It happens that precisely at this time, by the 90-degree arrangement of the cranks, the pistons on the other side of the machine are nearly in the middle position; the pressure behind the steam piston on that side has begun to fall, while the pressure before the advancing air piston has risen, so that pressure and resistance are approaching a balance, and to complete the stroke some assistance will be required. In this case, instead of getting this help out of the flywheel, it is secured through the shaft and cranks from the pistons on the near side of the machine which, just at this time, have power to spare. In the same way throughout the rotation of the crankshaft and the double strokes on the two sides of the machine, this reciprocal action of the one side upon the other is not only secured, but the excess in either direction is much reduced; and the calls upon the inertia of the flywheel to keep things going are much less, and even with less flywheel weight the running is much steadier.

The pressure relations in the four cylinders of the duplex steam driven compressor at the four quarters of the stroke are graphically shown in the four diagrams following. For the sake of clearness, pressures on only one side of the pistons have been considered in these diagrams. The effect of back pressure in the steam cylinders on the other side of the steam pistons and the effect of suction pressure (if such a term may be used) on the other side of the air pistons, is neglected. These two elements in no way affect the theory of the relation of power to resistance on the pistons as indicated.

Fig. 1 shows the instantaneous pressures at the beginning of a revolution. In the lower cylinders there is no power and no resistance; in the upper cylinders there is excess power

and a small resistance. This excess power will be applied in carrying the compressor over the center of the lower half.

Fig. 2 shows the conditions a quarter of a revolution later. Here, in the two upper cylinders minimum power is being applied to maximum resistance at the end of the stroke; in the two lower cylinders excess power is being applied to small resistance at midstroke, the surplus pressure acting to carry the compressor past the center of the upper cylinders.

power in the lower section will carry the compressor over the center of the upper section and admit steam to the upper cylinder, which will be applied against the increasing resistance in the lower air cylinder.

MORE UNIFORM STEAM CYLINDER PRESSURES IN COMPOUNDING

It is an interesting thing that when four cylinders are adopted in a duplex, to secure a more uniform rotation effect and to make it possible to keep running at the lowest speeds,

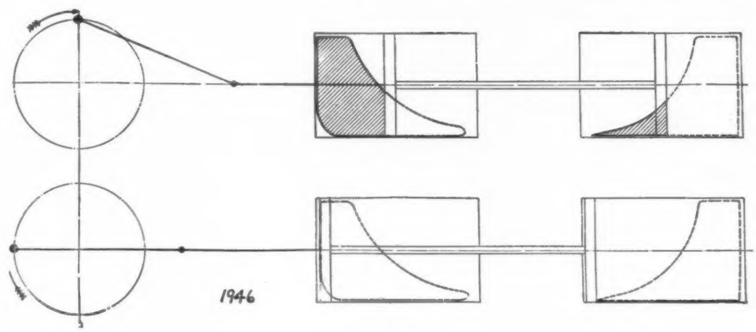


FIG. 1.

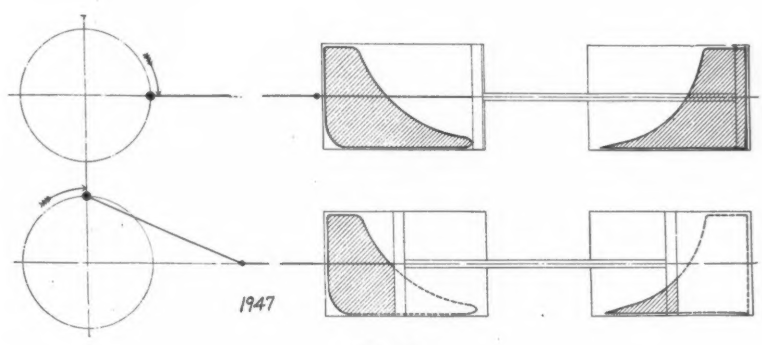


FIG. 2.

Fig. 3 shows the conditions on the return stroke, a quarter of a revolution later. In the two lower cylinders at the beginning of the stroke, power and resistance are *nil;* in the two upper cylinders the power exceeds the resistance and the excess power carries the machine past the center in the section indicated by the lower cylinders.

Fig. 4 shows the conditions after another quarter revolution has been made. Here the conditions are exactly the same as those in Fig. 2, but in reverse relation. The excess

the compounding of the cylinders helps to promote the original purpose of the duplex arrangement. At the steam end, because of the higher terminal, the variation in working pressure is less. The result is that the effective pressure for the stroke is more uniform and continuous, and the rotation effect produced from the beginning to the end shows less difference than when the steam is used in a single cylinder. The difference of pressures in the low pressure cylinder is less for the same reason.

CONDENSATION LOSSER REDUCED BY STEAM COMPOUNDING

Aside from this reduction in range of cylinder pressures, the differences in temperatures are a powerful element in economy. These two features will be more clearly understood by a brief consideration of a specific case.

Assume that the initial steam pressure is 145 pounds gauge, or 160 pounds absolute, and that a condenser gives a terminal cylinder pressure f say, 10 pounds absolute. Ignoring for the sake of clearness the effects of clearance, condensation, etc., there are seen to be 16 expansions of the steam. In compound steam cylinders, properly proportioned, this means 4 expansions in each cylinder. In the high pressure cylinder, the initial steam pressure will be 160 pounds and the terminal 40 pounds; the initial temperature will be 363 degrees F., and the terminal 267 degrees F. The difference of pressure is thus 120 pounds and in temperature 96 degrees. In the low pressure cylinder initial and terminal pressures will be 40 and 10 pounds, respectively, corresponding to temperatures of 267 and 193 degrees F. The difference in pressures is here 30 pounds and in temperatures 74 degrees.

If this expansion had been applied in a single cylinder, the range of pressures would have been 150 pounds and of temperatures 170 degrees F. Evidently the use of compound steam cylinders in this case reduces, by approximately one-half, the cooling effect to which cylinder walls, ports, valves, etc., were subjected by the drop in temperature through expansion. The steam consumption in the former case would have been correspondingly less, and the effect to temperatures on steam economy is apparent. If a condenser had not been used, the range of pressures and temperatures would not have been so great, but, relatively, as between compound and simple cylinders, the same comparison would hold.

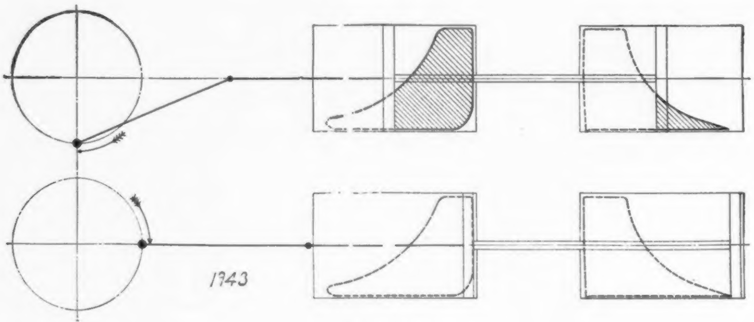


FIG. 3.

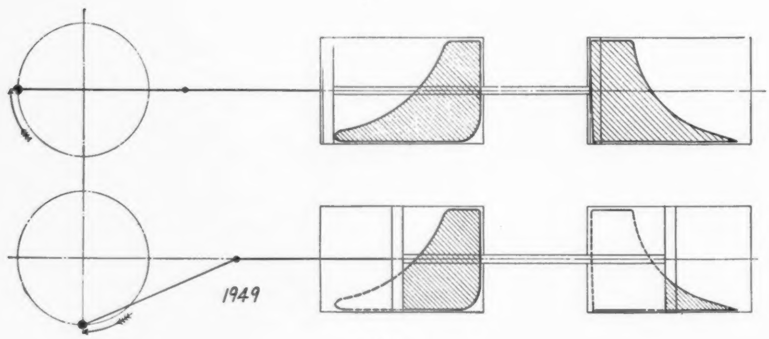


FIG. 4.

TO BE CONCLUDED.

COMPRESSED AIR ILLNESS OR CAISSON DISEASE. *

A PHYSIOLOGICAL AND CLINICAL STUDY.

By Thomas Oliver,
M.A., M.D., L.L.D., F.R.C.P.

Professor of Physiology College of Medicine and Physician to the Royal Infirmary, Newcastle-upon-Tyne.

(Concluded from February.)

WHAT ARE THE SYMPTOMS DUE TO?

Inside the caisson the men are working under abnormal conditions. The pressure is high, the work is hard, and the men are dependent for the air they breathe upon what is pumped into the shafts by the engines. One pound of air pressure, as already stated, is required to displace 2 feet four inches of water so that where men are working 70 to 80 feet below high water level mark they are under a pressure of not less than 35 lbs. to the square inch. As excavation proceeds and the caissons sink, the greater is the pressure required. The men are more liable to compressed air illness as the depth increases and the pressure rises; the same thing is noticed when the shifts are longer, also the less pure the air and the smaller the quantity of fresh air sent into the caisson. On the Tyne most of the cases of compressed air illness occurred when the men were on the night shift. Why this should be it is difficult to say, for the length of the day and night shift is the same. Some of the cases occurred when the men were *not* working at *maximum* pressures at all, but when they were digging through a layer of soft coal in the bed of the river and from which H_2S escaped into the caisson. At the Forth Bridge, Dr. Hunter noticed that the men suffered most when they were removing the soft silt on the bed of the river. Not only must pure air be sent into the caisson, there must be plenty of it, and provision made for the ready escape of the surplus air by the bottom of the caisson, so as to secure adequate ventilation.

In studying the effects of very high pressures of atmospheric air, the part played by the oxygen tension must not be lost sight of, for when breathed under very high pressure oxygen becomes a poison. It rapidly induces toxaemia. Paul Bert found on exposing dogs to high pressures of oxygen, and rapidly decompressing them that the animals became convulsed, and on analysing the gases of the blood during the convulsions he found that the carbon dioxide had fallen to 14.8 and 10.5 per cent.

He therefore concluded that excess of oxygen arrested metabolism. In a series of experiments which I lately carried out at the Newcastle College of Medicine with my former house physician, Dr. Parkin, I subjected mice to high pressures of oxygen 10 atmospheres and upwards. When the animals had been exposed for 5 or 6 minutes the breathing usually became hurried, and shortly afterwards the animals would fall to one or other side in a state of coma, the pupils became dilated, and the animals died in convulsions. They died asphyxiated probably because the CO_2 of the tissue was not removed, or it might be that the oxygen itself acted as a poison. One effect of the exposure of animals for a few hours to high pressures of oxygen is pneumonia. There are capillary haemorrhages and the alveoli of the lungs become filled with an inflammatory exudate, the lungs become semi-solid as in the early stage of pneumonia. To such an extent are the lung lesions developed under these circumstances that Prof. Lorrain Smith believes the inflammation of the lungs to be the cause of caisson disease. Against this must be placed the fact that some of the worst cases of compressed air illness that I have seen occurred when the men were not working at high pressures, and when therefore the oxygen tension was not great. Besides the major part of the symptoms of caisson disease occurs on the side of the nervous system, and not in the lung, they are too sudden for that. The symptoms that arise during exposure to high oxygen pressures are not so much due to the total quantity of oxygen in the blood as to the tension of the gas in solution. At any rate animals behave differently when exposed to the same pressures of oxygen and compressed air. When I had exposed mice for 6 minutes to 10 atmospheres of oxygen they became convulsed, but they could be exposed to much higher pressures of atmospheric air for similar length of time without convulsions occurring, probably because the length of time was not sufficient for oxygen poisoning to occur. With such high pressures of atmospheric air as 20 atmospheres or 300 lbs. to the square

* Abstract of a Lecture delivered to the "Genootschap ter Bevordering van Natuur-, Genees- en Heelunde", Amsterdam.

inch, and an exposure of the animal to such for 15 minutes, I found that invariably no symptom occurred until decompression was rapidly induced. The animals then became convulsed owing, not to oxygen poisoning, but to the setting free of bubbles of air from the gas that had been dissolved in the blood. The consequences therefore of the exposure of animals to high pressures of oxygen and of atmospheric air are not exactly the same. The convulsions of oxygen poisoning come on when the animal is in the pressure chamber, and are therefore the result of a toxaemia, but in the case of compressed atmospheric air they develop only after the animal has been rapidly decompressed and taken out of the chamber, and are due to frothing of the blood in the heart, and small blood vessels. During the time a workman is in a caisson the circulation of the blood in his vessels remains practically the same as if he were outside, but the air that he is breathing becomes dissolved in his blood in proportion to the pressure, and since four-fifths of the air he is breathing is nitrogen it is this gas which forms the largest constituent of the gases dissolved in the blood and which is afterwards liberated during rapid decompression. When atmospheric air contains excess of carbonic acid, or has become accidentally polluted by even small traces of carbon monoxide or sulphuretted hydrogen there is increased danger to life from toxaemia. So far as having been exposed to high atmospheric pressures is concerned the effect of sudden decompression is appropriately illustrated when the cork of a soda water bottle is drawn, there is effervescence. After having exposed pithed frogs to high oxygen pressures, say 300 lbs., and having suddenly decompressed them, I noticed that while no apparent effect was immediately produced in the circulation yet in 2 to 3 minutes afterwards the stream of blood was observed to slacken and to oscillate, now backwards, now forwards, that a bubble or two of gas appeared inside the capillary towards the venous side, that these bubbles of air coalesced and ultimately filled a considerable portion of the blood vessel. The circulation thereafter ceased in that vessel for it was occupied by air. Occasionally a vessel ruptures, and there is escape of blood into the surrounding tissues. On making microscopical sections of the brain and liver of some of the animals that I had exposed to high pressures of atmospheric air, which had been rapidly decompressed, and had died in consequence of the rapid decompression there can be seen numerous circular spaces in the brain the result of extreme dilation of capillary blood vessels, while in the liver in addition to large spaces that had evidently been filled with air, there are several excessively dilated blood vessels, haemorrhages and tearing of the liver tissue.

Caisson disease is therefore in my opinion the result of mechanical causes, and not of toxaemia, and yet some influence must be exerted as previously stated by the presence of impurities in the air inside the caisson, and the hard character of the work the men are engaged in. Since, however, the symptoms of genuine caisson disease occur in men who have been working in compressed atmospheric air free from impurities, and can be produced experimentally in animals under similar circumstances I am of the opinion that frothing of the blood or the sudden liberation of gas in the blood vessels is the chief cause of compressed air illness, and that in most cases it is due to the men spending too little time in the air lock during decompression. Pol and Wattelle considered the symptoms to be the result of the blood being driven by the compressed air from the peripheral parts of the body to the internal organs, and causing congestion of these organs. Dr. Andrew Smith believes them to be the result of a congested state of the capillaries of the nervous system and that the distended blood vessels do not recover their elasticity quickly enough when the compression is removed. Corning, who gained his experience of caisson disease during the construction of the tunnel under the Hudson between New York City and Jersey, believes the symptoms to be the result of the sudden rush of blood to the periphery during decompression, and the consequent rapid diminution of the circulation in the central parts of the body. Of the two theories therefore advanced to explain caisson disease the hydraulic or distended vessel theory and the pneumatic or the theory of the liberation of gases in the blood there can be no doubt as to which is the more likely.

Experimental investigation, clinical experience and pathological fact all lend support to the opinion that caisson disease is the result of the setting free of gas in the blood and in the fluids of the tissues. It is to Paul Bert we are indebted for having placed the pneumatic theory upon a scientific basis. For some reason or other the small blood vessels in the

lower portion of the spinal cord have to bear the brunt of the liberation of gas when decompression is too rapidly performed, hence the common sequence, paraplegia. When decompression on the other hand is effected very gradually nature provides for the escape of the gases, previously dissolved in the blood, little by little through the lungs. It is this silent and slow escape of gas through the lungs that is the saviour of the worker in compressed air. If we take the view that caisson disease is the result of mechanical causes, viz: too rapid decompression, then we are dealing with a malady that can to a large extent be prevented.

Breathing through the lungs is the outward sign of a deeper or "internal" respiration known as the respiration of the tissues. During internal respiration oxygen is removed from the haemoglobin of the red blood corpuscles by the tissues and carbon dioxide is given up by the tissues to the blood. Professor Merget, of Bordeaux, holds the view that there is a gaseous atmosphere in our tissues, and that this is the medium of respiratory interchange in the same manner as the atmospheric medium stands related to pulmonary respiration. He therefore maintains that in compression "the gases in the blood are diffused into the tissues until their tension has become equal to the tension of the compressed air." It is upon this equilibrium that freedom from symptoms depends. During rapid decompression this equilibrium is broken, and as the atmospheres of the tissues have still a higher tension than that of the air which was previously compressed they increase in volume and forcibly separate the tissues that surround them, causing accidents by lacerating the tissues or by leading to the development of intravascular bubbles of air or emboli. It takes a longer time for the tissues to become saturated with gas than it does the blood, hence short shifts of work are not nearly so dangerous to men as long shifts, for the less is the blood saturated with gas during compression and the smaller is the quantity of gas set free during decompression.

PREVENTION AND TREATMENT OF CAISSON DISEASE

Since caisson disease is largely the consequence of the liberation of gas in the blood and tissues owing to the time spent in decompression being too short, it is the duty of employers to see that the time spent in decompression is adequate and that the regulations are effectively carried out. The length of time spent by the men in the air lock will vary with the pressure they have been working in and the length of the shift. One minute for every 5 lbs. of pressure is the time allowed at the works on the Tyne. This is found to be quite adequate but the time might be slightly extended, for if anything, it is on the side of brevity. Nearly all physiologists admit that decompression is a procedure over which there ought to be no hurrying, and yet there is no unanimity in regard to their recommendations. Francois recommends, for example, 6 to 8 minutes for each increment of pressure equal to 1 atmosphere; Foley, 1 minute for each atmosphere; Barella 10 minutes per atmosphere, while Triger recommended only 7 minutes for the whole act of decompression irrespective of pressure. Paul Bert is in favor of short shifts and of extremely slow decompression and he recommends heating of the air lock. Hill and Macleod are of the opinion that when men are working under 30 lbs. pressure for 4 hours at a time the decompression period should be 30 minutes to 1 hour; 45 to 60 lbs. pressure and with 4 hours shift that the time spent in decompression should be 1 to 2 hours. It would be difficult to keep workmen in the air lock all this time undergoing slow decompression, for the air inside is extremely cold, and the air locks can not be readily heated and ventilated; besides the air locks are usually too small. No man who is an alcoholic should be allowed to work in a caisson, nor anyone who is suffering from nasal or laryngeal catarrh, or who is the subject of weak heart or diseased lungs. Young men between the ages of 20 and 30 whose tissues are still elastic do the work better than those of maturer years, also men who are of rather slim than stout build. All workmen should be medically examined when taken on for the first time. The Dutch regulations require that the men should be seen daily by the medical officer in charge, and this is a step in the right direction.

Ventilation of the caissons is most important. It is difficult to say under what limits of pressure men can work in caissons consistent with safety and effectiveness. The greater the depth that is reached, and the higher the pressure, the shorter must be the shifts since the longer there is exposure to high pressure of compressed air the greater becomes the risk of oxygen poisoning. It is possible to subject animals to 8 atmospheres of air or 120 lbs. pressure for 5 hours every alternate day for a period of safety, so long as plenty of time

is spent in decompression e. g. 1 to 2 hours. I exposed a mouse to 20 atmospheres of compressed air i. e. 300 lbs. pressure for 10 minutes, but the pressure had to be lowered from time to time on account of muscular tremors the result of oxygen intoxication. Although 15 minutes only were spent in decompression of this animal and the mouse on its removal from the chamber seemed indisposed and unwilling to move, yet the animal has remained well ever since. H. Von Schrotter 1) has suggested that caisson workers should wash out from their blood and tissues the nitrogen absorbed during their work in high air pressures by breathing pure oxygen for 5 minutes before undergoing decompression. Theoretically the recommendation is sound and it has been proved experimentally to be efficient in preventing death from air embolism although the method requires consideration and attention. A rat exposed for 5 minutes to 20 atmospheres of oxygen will have very few bubbles of gas in its blood after rapid decompression; it will be convulsed, but it will live, while another rat exposed to similar pressure of atmospheric air will be instantly killed by rapid decompression and numerous bubbles of air will be found in its blood and tissues. Schrotter's recommendation might be adopted with safety for low pressures, say anything under 50 lbs., but above this we have to remember that oxygen itself becomes a cause of danger by producing toxaemia and inflammation of the lungs. Below 50 lbs. pressure decompression, if slowly and gradually carried out, can accomplish all that is required so far as the safety of the workmen is concerned.

RECOMPRESSION.

Workmen on coming out of the air lock are often seized with severe muscular pains which experience has taught them will be relieved if they will at once re-enter the air-lock, and allow themselves to be again compressed and afterwards very slowly decompressed. Recompression has therefore come to be a recognized method of treating caisson disease. By physiological experimentation on animals I have confirmed the value of recompression. There ought to be therefore at every large engineering undertaking where caissons are employed a medical lock into which the workman could be placed immediately they show symptoms. By this means not only could the muscular pains be treated but possibly more severe symptoms as well. In the case of a frog which I had subjected to a pressure of 20 atmospheres, and rapidly decompressed, and whose respiration had ceased the breathing became re-established under the influence of recompression. The medical lock should be large enough to accommodate 3 or 4 men of whom 2 could be in the recumbent position, and the chamber should be capable of being warmed and ventilated.

Attention to these and some of the other details mentioned in this lecture ought to enable engineers, and bridge builders to undertake, and to carry to a successful issue engineering operations upon even a greater scale than they have hitherto done, operations that would be quite consistent with the health, and with the safety of workpeople.

1) Der Sauerstoff in der Prophylaxis und Therapie der Luftdruck-Erkrankungen, Berlin, 1904.

COMPRESSED air locomotives are built to run one-half to three miles without being recharged. This distance can be doubled if storage tanks are carried on the tender. The time required for recharging is about one and one-quarter minutes.

THOUGH the demand for pins the world over is enormous, the mills of the United States practically supply the entire demand. Formerly pins were expensive, but now they cost a mere trifle. In 1905 the 75,000,000 people in the United States used 60,000,000 gross of common pins, which is equal to 9,500,-000 pins, or an average of about 126 pins for every man, woman and child in the country. This is the highest average reached anywhere in the use of pins. Ten years ago we used only about 72 pins each. The total number of pins manufactured in the United States during 1900, the census year, was 68,889,260 gross. There are 43 factories in all, with 2,353 employes. The business has grown rapidly during the last 20 years, for although there were 40 factories in 1880 they produced only half as much, employed only about half the capital and only 1,077 hands.

One of the causes of a serious loss in the transmission of compressed air is pumping the air of the engine room rather than air drawn from a cooler place. This loss amounts to from 2 to 10 per cent.

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Established 1896.

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HENRY C. SERGEANT

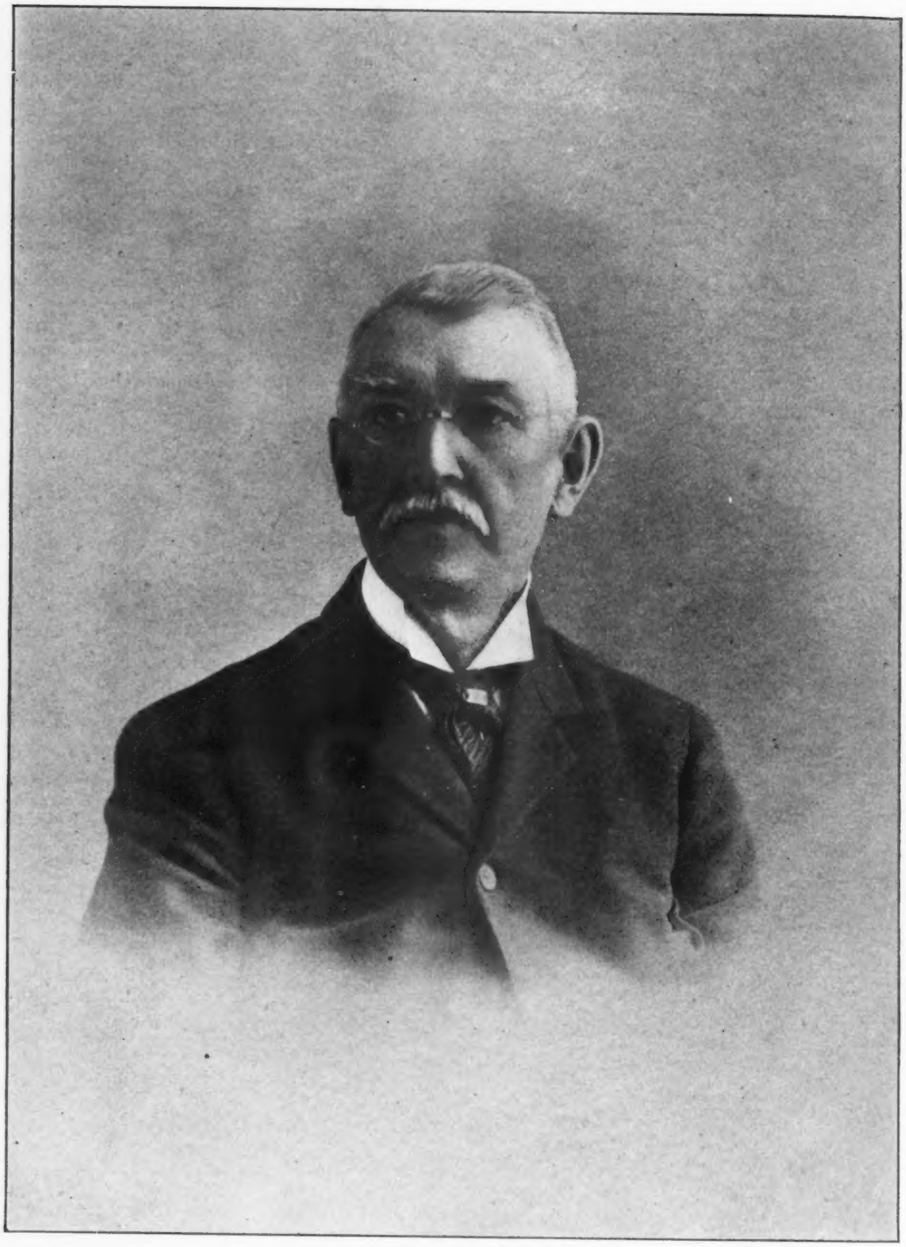
Henry Clark Sergeant of the Ingersoll-Sergeant Drill Company—now an integral part of the Ingersoll-Rand Company—died at his home, Westfield, N. J., Jan. 30th, seventy-two years old.

Mr. Sergeant was of world-wide repute as a facile, prolific and highly successful inventor, especially in the line of rock-drills, air-compressors and mining and excavating machinery in general, his active life having been coincident with the period of development of the modern and phenomenally efficient apparatus now so universally employed and with such industriously revolutionary results, he having been a leading and constantly active agent not only in the line of invention and improvement but also in the devising of the details and the means of precise and economical manufacture.

Mr. Sergeant was born at Rochester, N. Y., but his earlier years were spent in Ohio. He was of uncurbable activity, both physical and mental, from the beginning. He had only a common school education and was working in the machine shop at a very early age. His irrepressible inventive faculty made work for itself from the first. He quickly began to see the undeveloped possibilities of systematic manufacture by the aid of special machinery. His first practical application of his theories was to the making of the spokes, hubs and felloes of wagon wheels. He designed some special machines for this work and at the age of eighteen he accepted a contract for manufacturing wheel parts in quantity. In this he was so successful that in two years he was taken into partnership by a firm manufacturing wagon wheels.

The routine of the factory, however, could not hold him and after severing this first business connection the next six years of his life were spent in various pursuits, chiefly commercial, in which he met with varying success. He was a ready speaker, though not known as such in later years, and found favor as a lecturer. He had figured for a time also as a champion skater. He still found time and opportunity in the line of invention and the development of labor saving machinery. His first U. S. patent, issued when he was nineteen, was for a boiler feed. Succeeding patents suggest the range of applicability of his inventive faculty. In December, 1858, he patented a steam engine governor. This was in fact a governor for marine engines to prevent their racing to destruction when the wheels are out of water. This was soon after adopted by the U. S. Government and applied to the warships of the period. He had after that patents respectively for gas regulators, for steam pumps, four for steam boilers, five for brick machines, a fluting machine, six for water meters, all these before he had struck what must now be considered as his life work.

Three of the brick machine patents were issued in 1867, when he was a resident of Columbus, Ohio, but soon after that he started a machine shop of his own in New York, building a wide variety of machines and developing many crude ideas into practical working successes. In the early seventies hither came Simon Ingersoll with the drawings for the first Ingersoll rock drill, a then untried device. The possibili-



HENRY C. SERGEANT.

ties of and the large future for the rock drill particularly attracted Sergeant. None can say now how much he contributed to the development and success of the original Ingersoll drill, but at least one patent was issued to Ingersoll and Sergeant as joint inventors. The Ingersoll Drill Company was formed and introduced the drill in the rock excavating fields.

Although the drill was at first operated by steam its advantages when driven by compressed air and the absolute necessity for using air for mine and tunnel work turned Sergeant's attention to the improving of the design and details of the air compressors, which the Ingersoll Company began to market in connection with the drills and for other incidental uses which began to develop.

He was soon working with all his energies in both lines and constantly bringing both the drill and the compressor into higher offices. As the business grew the partnership of Sergeant and Cullingworth was formed with shops at 22nd Street and Second Avenue, New York.

The water meter patents spoken of, were issued during these early business years in New York, and in this line he was in touch with Jose F. de Navarro, two patents issuing to him as joint inventor with Sergeant.

Again turning from the task of manufacturing, Mr. Sergeant's interest was sold to the Ingersoll Drill Co., and he went to Colorado to put into practical operation some of his mining methods. He operated a silver mine for a time, but fortunately we may now say, it was not a success. Meanwhile he had developed another complete rock-drill with an entirely novel valve motion. Two patents on this drill are dated 1884. He brought his new drill East in 1886 and formed the Sergeant Drill Company, which began building the drill at Bridgeport, Conn. Two years later the new company joined hands with the Ingersoll interests and the Ingersoll-Sergeant Drill Company was formed with Mr. Sergeant as its first president. The new company's shops were at 9th Avenue and 27th Street, these shops having been occupied for a short time previously by the firm of Sergeant-Cullingworth, which then went out of existence, Mr. Sergeant's interest in this firm having terminated before he went to Colorado. Mr. Sergeant remained at the head of the company but a short time, he then disposing of the bulk of his interest. A considerable time was then spent in London and Paris. He returned to the rock-drill-business, this time as a director in the Ingersoll-Sergeant Company, with the purpose of devoting all his time to invention in the interest of the company. He labored constantly in developing and improving the company's products and in spending their application into new and wider fields, his most notable inventions being the Sergeant "Auxiliary" and "Arc" valve, "Tappet" rock-drills, the Sergeant Release Rotation for rock-drills and the Piston Inlet valve for air compressors, all of which are in general and successful use to-day. He was also the originator of many new ideas in stone channeling, coal undercutting and associated lines.

In the days of the Sergeant-Cullingworth Company, in response to the solicitations of the management of the Third Avenue Elevated Railroad Company, of which he was then a director, for a device which would protect them from the constant losses accruing from the repeated use of uncancelled tickets, he designed the ticket cancelling box now so familiar to the public which so mutilates the ticket as to make it impossible to defraud the company by using it again.

Mr. Sergeant's inventive faculty and his suggestive and stimulating ideas were devoted to the interests of the Ingersoll-Sergeant Company for all the remaining years of his active life, and the business grew and prospered continually. The works at Easton, Pa., were occupied in 1873, the great shops at Phillipsburg being a necessity a decade later. He spent much of his time in Easton until two years ago, when failing health compelled him to give up his former activities.

After the consolidation of the Ingersoll-Sergeant and Rand companies, he still retained his interests, although his health would not permit his active participation.

In his early days Mr. Sergeant was never content to tarry long under fixed conditions or in the same location, and up to 1893 he had made his home in twenty-six different cities

and towns. In that year he located at Westfield, N. J., and at once took a deep interest in the growth of what was then but a small settlement. He built and owned at the time of his death the present home of the Westfield Club, the leading social organization in that section. He was a great sufferer from rheumatism in his latter years, but the immediate cause of his death was paralysis. He is survived by three daughters, a son and a brother. Mr. Sergeant was a man of all-embracing interests and of most extensive experience, a genial companion in the hours of leisure as he was an indefatigable worker when anything was to be done. He was absolutely without ostentation and there was no suggestion about him of his talents or his achievements. He had, however, an unbounded confidence in his abilities as all must have who accomplish much.

Mr. Sergeant is to be considered to have been a fortunate inventor, in that his inventions were so completely successful in the accomplishment of the purposes for which they were designed and have attained such a leading position in the large operations which accompany the advance of modern civilized life, although he realized from them no great fortune, as fortunes go now, and at best attained little more than a modest competence.

The world was most fortunate in the life work of such an inventor in the special line which engaged him. The importance of Mr. Sergeant's labors will be appreciated only when the results which he made possible are realized; and when will that be? Without the rock-drill, which he did more than any other man to make a success, such enterprises as the Chicago Drainage Canal, the Niagara power development, the New Croton Aqueduct, the New York Subway, the Panama Canal, the subaqueous tunnels now being built in and for Greater New York, would not have been commercially possible. Added to this list of achievements done, or now certain of accomplishment, directly due to Sergeant's genius must be named the gigantic railway system of America which could never have been built without the rock drill and the air-compressor, for tunneling, for heavy rock cuts, which give easy grades, etc. The mineral output of this and of all other countries in gold, silver, copper, iron, coal, building stones, etc., has been multiplied over and over by the rock-drill alone.

As an inventor he had probably no special predilection in the direction of the specialties in which success came to him, his real specialty being merely to accomplish the thing which it thus came in his way to do. His chief characteristic may be said to have been a certain mental alertness, a quickness to see the best way to do a thing or in ways already devised to see the little thing lacking, and to supply it, transforming a device of doubtful value often into a great success. This faculty he applied as he had opportunity to the inventions of his competitors, as he had an undoubted right to do, and as it was to the interest of mankind that he should do, and in which he was as far from being a plagiarist or a mere adapter as if a competitor had never existed. The pronounced and indisputable character of his inventions is attested by the fact that with more than fifty patents to his name so few of them have ever been subjects of litigation.

"SALES NIGHT"

"Sales Night" of the Technical Publicity Association was held at the rooms of the Aldine Association, 111 Fifth Avenue, New York, Thursday, January 31 The Association received the first report of its Circulation Committee, which has been requesting reports on circulation, etc., from the various technical magazines in which T. P. A. members are interested. As was expected, the stronger magazines have shown themselves eager to go on record with detailed statements.

The companies represented by members at the meeting were: Yale & Towne Mfg. Co., Johns-Manville Co., American Wood Working Machinery Co., F. R. Almond Mfg. Co., General Electric Co., Crocker-Wheeler Co., American Locomotive Co., Cameron Steam Pump Works., N. Y. Telephone Co., N. Y. Edison Co., B. F. Sturtevant Co., A. A. Griffing Iron Co., A. Allan & Son, Goulds Mfg. Co., Prentis Tool & Supply Co., J. G. Brill Co., and Lidgerwood Mfg. Co.

TRADE PUBLICATIONS

Struthers-Wells Company, Warren, Pa.—28-page catalog and price list of boilers for permanent and portable work, also 42-page catalog illustrating the full line of steam and gas engines, boilers, tanks, etc., manufactured by this company.

T. H. Proske, 1734 15th St., Denver, Colo.—Small booklet describing the Ajax Drill Sharpener, having a capacity of 1,200 drills in 24 hours. The booklet also contains a great deal of interesting data on the subject of drill bits.

Armour Institute of Technology, Chicago Ill.—Fourteenth Annual Year Book for 1906-1907, giving full information regarding the various engineering courses offered by the Institute.

St. Louis, Well Machine and Tool Company, St. Louis, Mo.—Circulars A to L, illustrating the full line of portable drilling machines and drilling tools manufactured by the company.

Joseph T. Ryerson & Son, Chicago, Ill.—Monthly stock list and journal giving full information regarding the material which they carry in stock for immediate delivery together with interesting articles covering engineering and business subjects.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill.—Catalog No. 21, 60 pages, 6x9, covering their line of electric drills, grinders, drilling stands, etc. This catalog is fully illustrated and the information regarding machines is placed in tabular form.

Arthur Koppel Co., 68 Broad street, New York—Catalog No. 111, 48 pages, 8x10, covering their complete line of Industrial Railway Equipment for manufacturing plants, quarries, contractors' work, power plants, etc.

Automatic Oil Cup Company, 155 Huron St., Milwaukee, Wis.—12 page booklet, 6x9, devoted to the subject of lubrication and explaining the uses of the Bangs Automatic Oil Cup to various classes of machinery.

Ingersoll-Rand Company, 11 Broadway, New York—Catalog No. 46, 84 pages, 6x9, devoted to Rand Rock Drills, their construction and operation. This catalog gives full information regarding the Rand Little Giant Drill and various fittings, such as tripods, quarry bars, drill steels, air and steam hose. The catalog also covers thoroughly the design and adaptability of the Rand Slugger Rock Drill.

Catalog No. H-36 describing a single line of air compressors known as Type H. These compressors are duplex, steam-driven, automatic machines, mounted upon a single base and entirely self-contained.

Booklet, 12 pages, 6x9, entitled "Some Economical Applications of Compressed Air in Cotton Industries." This interesting pamphlet calls attention to the safety, especially as to fire, of compressed air as a motive power in cotton factories, and points out the numerous ways in which it may be used to advantage.

Western Electric Company, New York.—Souvenir book, 24 pages, 10¾x7½, describing and illustrating their Hawthorne Works for the manufacture of power apparatus.

The Railroad Supply Company, Chicago Ill.—Small booklet, 140 pages, entitled "A Pocket Companion for Trackmen," containing a vast amount of useful data on track equipment and construction.

C. Drucklieb, 132 Reade St., New York.—Small booklet devoted to the subject of the application of the Injector Sand Blast Apparatus to railroad work, especially for cleaning steel bridges and other structural steel work. This booklet contains a great deal of valuable information regarding the application and operation of the Sand Blast.

Blaisdell Machinery Company, Bradford, Pa.—Bulletin No. 12, 28 pages, 6x9, devoted to a description of Blaisdell Self-oiling Air Compressors. This bulletin describes the new Blaisdell Air Compressor, mention of which was made in the February issue of COMPRESSED AIR.

Catalog, 46 pages, 6x9, devoted to Classes SA and DSA Air Compressors as well as pneumatic tools, plug drills, surfacing machines, unloaders, gasoline engines, etc.

Hanna Engineering Works, 820 Elston Ave., Chicago, Ill.—12-page folder illustrating and describing Hanna Riveters for structural steel work. This riveter is claimed to be the only pneumatic machine which will exert a positive uniform maximum pressure on the rivet throughout the last half of piston travel. Furthermore, it requires no adjustment for ordinary variations in length of rivets or thickness of plates.

Allis-Chalmers Company, Chicago, Ill.—Catalog No. 17, 6th Edition, 12 pages, 6x9, describing their line of mining and quarry cars, skips and buckets, with a detailed description

of their Anaconda Car Axles. This catalog also contains information on ore buckets, water buckets, automatic dumping cars and scoop ore cars.

Marceline Steel Company, 13-21 Park Row, New York.—Small booklet, 3½x6, 12 pages, describing a new high-speed steel, made in three grades, i. e. Marceline "Three Star," Marceline "Two Star" and Marceline "One Star." It is claimed by actual tests in England and on this Continent that this steel has proven 100 per cent. better, both in speed and lasting qualities, than any other steel. Furthermore it has the peculiarity that when re-ground it works much better than when new. One of its chief characteristics is that when hardened it remains tough, and does not have any tendency to crack and chip when made into milling cutters and other tools of like nature. This steel requires no treatment, and by its use any toolmaker can produce high-grade tools without special instructions.

INDUSTRIAL.

CHICAGO PNEUMATIC TOOL CO.

In his report to the stockholders of the Chicago Pneumatic Tool Co. for the year ended December 31, 1906, President J. W. Duntley makes reference to the statement in the previous annual report of the policy of the management in "developing, broadening and extending" the business of the company, and adds:

"The largely increased sales and profits realized, amounting to 11.237 per cent. available for dividends, would indicate that substantial results have been obtained. Of the amount earned during the year, amounting to $686,468.61, available for dividends, your directors have appropriated 4 per cent. for dividends declared, and the remainder, amounting to $442,117.29, has been added to surplus account."

HAS GREATER MARKET.

The company has acquired the Consolidated Pneumatic Tool Co., Ltd., of London, and has organized the Internatinale Pressluft & Elektrigitaets-Gesellschaft, Berlin, and has bought the Canadian Pneumatic Tool Co., Ltd., Montreal. All of these organizations, says the report, show during the year increased volume of business and substantial gains in assets with the result that the company has benefited in additional facilities for marketing its output, with resulting increased profits. In connection with the acquirement of the business of the Philadelphia Pneumatic Tool Co. of Philadelphia, and the organization and extension of the foreign companies. it was thought desirable to borrow temporarily $195,000, which is included in the item "Bills payable," amounting to $247,499.94. The amount so borrowed has been more than offset, the report asserts, by the additional assets acquired.

Additions to plants have been made during the year and development work completed has exceeded that of the previous year.

Mention is made of the fact that of the authorized issue of $2,500,000 bonds, $200,000 are still in the treasury, and $293,000 have been retired for sinking fund purposes, leaving outstanding $2,007,000. The excess current assets on December 31, 1906, $1,542,075.99, show an increase of more than $883,000.00 since the company was organized five years ago.

THE James Leffel Co., Springfield, Ohio, have issued a very handsome and complete new 52-page catalogue, illustrating and describing their line of steam engines and boilers. The details of construction are plainly shown and fully explained, and the catalogue is one that should be in the hands of any prospective purchaser of work in the steam power line. A copy will be furnished free to prospective buyers, stating their wants, and addressing the company as above. In writing for this catalogue request Catalogue "O."

WEIGHING COMMON AIR

The weight of air has often been tested by compressing it in receptacles by the air pump. That it really has weight when so compressed is shown by the fact that the weight of the vessel is increased slightly by filling them with compressed air and that such vessels become specifically "lighter" as soon as the air contained in them is exhausted. Many elaborate experiments on the weight of air have proved that the cubic foot weighs 536 grains, or something less than one and a quarter ounces. The above experiment on the weight of air is supposed to be made at the surface of the earth with the temperature at 50 degrees F. Heated air or air at high elevations is much lighter.

The Independent Pneumatic Tool Co. of Chicago announce that the sales of their "THOR" Pneumatic Tools and appliances during 1906, showed an increase of 50 per cent. over 1905, and they are now several months behind in their orders.

On account of the rapidly increasing demand for their products, their present manufacturing facilities are inadequate to meet requirements, and they have accordingly, purchased a large four-story brick building adjoining their plant at Aurora, Illinois, which will give approximately 100,000 square feet of additional floor space, and they intend to install therein, at the earliest possible date, about $65,000 worth of additional machinery of the latest improved type. By the acquisition of the building mentioned, and additional machinery, they expect to double their output this year. Mr. A. B. Holmes, who is at present Secretary of the Company, has also been elected Treasurer, effective January 16th. The Board of Directors at a recent meeting declared a regular quarterly dividend of 3 per cent.

IN STOCK FOR IMMEDIATE SHIPMENT.

Messrs. Joseph T. Ryerson & Son, Chicago, announce that they have the following machinery in stock for immediate shipment:

One 6 inch throat punch, capacity ½ inch hole in ½ inch plate.

Two 12 inch throat punches, capacity ¾ inch hole in ¾ inch plate.

Two 36 inch throat punches, capacity ¾ inch hole in ¾ inch plate.

Three 36 inch throat punches, capacity 1 inch hole in 1 inch plate.

Three Lennox Rotary Splitting shears for ½ inch material, 30 inch throat.

One Lennox Rotary Splitting shears for ¼ inch material, 42 inch throat.

Three Lennox Rotary Splitting shears for ¾ inch material, 8 feet between housings.

One combination punch and shear, 15 inch gap, capacity ⅝ inch hole in ⅜ inch plate and as a shear 1¼ inch round bars.

One hand power beam shear, capacity 15 inch, 60 lb. I beams.

One Alligator Riveter, capacity 1 inch rivets.

One set of bending rolls, capacity ⅜ inch material, 6 feet 2 inches between housings.

One 600-lb. Bell Standard Guide Steam Hammer.

One 10x8 Belt driven Air Compressor.

One 10x10x10 Steam-driven Air Compressor.

Besides the above mentioned, they carry at all times rotary bevel shears, flue welding machines, flanging clamps, power hammers, and a full line of miscellaneous hand and power tools.

CONVENTION OF THE ASBESTOS MEN.

Annual Meeting of the Sales-Staff of the H. W. Johns-Manville Co.

During the past month the various branch managers and department managers of the H. W. Johns-Manville Co., held their Annual Convention at the headquarters of the company, 100 William St., New York. This company has a world-wide reputation as being the largest manufacturer of asbestos, magnesia and electrical products in the United States, if not in the world, having factories at Brooklyn, Milwaukee, West Milwaukee and Hartford Conn., and branch offices and warerooms in the following cities: Milwaukee, Chicago, Boston, Philadelphia, St Louis, Pittsburg, Cleveland, San Francisco Los Angeles, Seattle, Kansas City, Minneapolis, New Orleans, Dallas and Buffalo. Representatives from the various branches and factories were present, and the meeting was not only profitable but interesting to everyone present.

As a fitting finale, the Convention wound up with a banquet at the Waldorf Astoria.

A GUIDE TO NEW YORK

"A Day in New York" is the title of an interesting and helpful little booklet issued by the Joseph Dixon Crucible Company for visitors to the metropolis. General information as to the topography of the city, its main thoroughfares, points of interest, churches, etc., is given.

A unique feature, and one which will appeal to the visitor whose time for sight-seeing is limited, consists in plans for one-hour, two-hour, half-day, evening and whole-day tours of the city. The routes are carefully planned and remarkably comprehensive. Hints for saving time and trouble, rates for cab and coach hire and a list of subway stations complete the book.

The prospective traveler to New York, be he teacher or business man, should not fail to write for a copy to the Joseph Dixon Crucible Company, Jersey City, N. J.

CHIPPINGS.

SIZE AN IMPORTANT FACTOR IN PNEUMATIC TIRE DESIGN

Compressed air in motion generates heat. The faster the speed the greater the heat; the greater the heat, the greater the strain on the tire; the larger the tire, the less the increase of heat and strain. So it will be understood that the faster the speeed the greater the load per wheel and tire. If there is not sufficient volume of compressed fluid air within a tire to absorb the whole of the shock or vibration the surplus shock is received by the cover of hte tire, which dashes it to the car and engine, causing damage to tire and to sar in a manner similar to the way in which a pool of water receives a solid bayd thrown into it. If the pool be small, the reception of the shock causes a violent dashing of water against the banks; if the pool be large enough the disturbance is imperceptible. As the compressed fluid air within a tire must be reached through the solid cover, it stands to reason that the cover should be as yielding, flexible and sensitive as is consistent with road wear, to interfere as little as possible with quick communication of shock to the fluid cushion.

At several mines in Europe small compressors, electrically driven, have been installed underground, each compressor serving a group of drills. The compressor, motor and receiver are sometimes arranged on a truck, which can be moved to follow the development of the mine. The electrical cable is wound on a drum, enabling an easy adjustment of the length. The efficiency of these installations has been found very good. By this method the theoretical advantage of the electric drill is approached, while the practical advantage of the air drill is retained.—*Engineering and Mining Journal.*

Well drillers desiring to calculate the rate of flow of an artesian well lower a bottle of aniline fluid to a depth of, say, 500 feet, and then electrically explode a cap to burst the bottle. The time required for the fluid to appear at the surface gives an accurate gauge as to the velocity of flow. It is claimed that this method gives results as accurate as a weir. The diameter of the pipe being known, the rate of flow readily follows.

When a shaft is sunk by the pneumatic process the lining is generally called a caisson, which in form may be likened to (as far as the water shell is concerned) an inverted tumbler, charged with air above the normal pressure, the edge of the glass representing the cutting edge of the caisson and the top the base upon which the winding apparatus, locks, etc., are placed. The weight of the caisson, including the superstructure, forces the cutting edge into the strata, and as the strata inside are removed the caisson sinks and forms the wall of the new shaft. As a general rule, little or no additional weight other than that of the winding apparatus and locks is required at the early stages of the sinking, but, as the friction caused by the strata pressing against the outer wall of the caisson increases, additional weight is required to be added to the superstructure. The weight is very considerable, and may run into hundreds of tons. Where the strata consists of soft material, and the digging inside the caisson is evenly done, the keeping of the structure in a vertical position is not, as a rule, a very difficult matter; but in the event of the caisson deviating from the plumb line, as it may do through subterranean influences, or through the occurrence of boulders in the strata, the additional weight must be so distributed as to check or remedy the defect during the continuance of the sinking. The compressed air inside the caisson retards the lowering of the structure, and as a rule the air pressure is reduced in the absence of the workers so as to allow the caisson to sink.—*Mining Reporter.*

One distinct advantage resulting from the use of machines in coal mining is due to the increased safety afforded the miner. This is especially true in a high seam (7 ft.), where the miner often attempts to get down the coal by using a heavy charge and shooting on the solid. Where such a hole is improperly loaded or wrongly placed, a blow-out or windy shot results, sometimes causing gas or dust explosions. If machine undercutting is practiced, the explosion has two free faces on which to exert its force instead of one, so the danger of missed shots is greatly lessened. It is a serious question whether it would not be best for all States to prohibit shooting coal from the solid.—*Engineering and Mining Journal.*

U. S. PATENTS ESPECIALLY PREPARED FOR COMPRESSED AIR

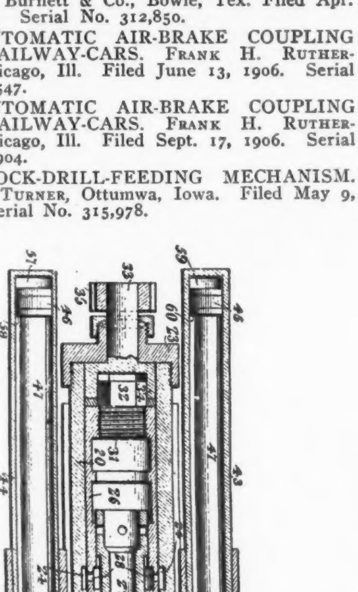
Full specifications regarding any of these patents may be obtained by sending five cents to the Commissioner of Patents, Washington, D. C. (Stamps will not be accepted.)

843,598. STEAM AND AIR VALVE OPERATOR. DAVID H. GREESON, Bowie, Tex., assignor to Greeson, Burnett & Co., Bowie, Tex. Filed Apr. 20, 1906. Serial No. 312,850.

843,701. AUTOMATIC AIR-BRAKE COUPLING FOR RAILWAY-CARS. FRANK H. RUTHERFORD, Chicago, Ill. Filed June 13, 1906. Serial No. 321,547.

843,702. AUTOMATIC AIR-BRAKE COUPLING FOR RAILWAY-CARS. FRANK H. RUTHERFORD, Chicago, Ill. Filed Sept. 17, 1906. Serial No. 334,904.

843,718. ROCK-DRILL-FEEDING MECHANISM. THOMAS TURNER, Ottumwa, Iowa. Filed May 9, 1906. Serial No. 315,978.



Claim.—In mechanism of the class described, the combination, with a motor, of a plurality of fluid-actuated feeding devices for moving the motor, and means for admitting motive fluid to one or more of the feeding devices to vary the pressure thereof upon the motor.

843,758. AIR-BRAKE SYSTEM. GEORGE MACLOSKIE, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. Filed June 22, 1906. Serial No. 322,845.

843,806. PNEUMATIC CONVEYER. CLARENCE L. GROVES. Hartford City, Ind., assignor, by direct and mesne assignments, of one-half to George R. Meyers and one-half to T. J. D. Larmoyeux, Hartford City, Ind. Filed Apr. 27, 1906. Serial No. 314,028.

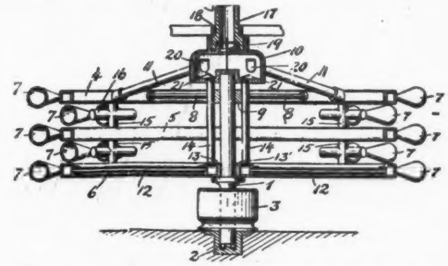
Claim—1. A pneumatic conveyer having a fan, a fan-chamber, a tangential feed-pipe, an air-inlet to the fan-chamber adjacent to the point where the tangential feed-pipe connects with the chamber, a door in the lower portion of the fan-chamber, and a tangential outlet-pipe.

843,909. ATMOSPHERE-REGULATING SYSTEM. FRANK M. PETERS and HENRY H. HUNGERFORD, Chicago, Ill., said Hungerford assignor to said Peters. Filed June 8, 1903. Serial No. 160,620.

843,926 PROTECTING OBJECTS FROM WAVE ACTION. PHILIP BRASHER, New York, N. Y. Filed Nov. 22, 1906. Serial No. 344,553.

Claim—1. The method of protecting objects from the action of water-waves which consists in discharging a compressed elastic fluid below the surface of the water between the object and the approaching waves and at a substantial distance from the object.

844,173. AIR-COMPRESSOR. ALEXANDER McCARTHY, New York, N. Y. Filed Dec. 2, 1905. Serial No. 289,943.



Claim.—1. In an air-compressor, a plurality of tubular rings, means for supporting and rotating said rings, and a plurality of air-receiving buckets carried by said rings.

844,270. AIR-BRAKE ATTACHMENT. GEORGE EMERY, Argenta, Ark. Filed Apr. 7, 1906. Serial No. 310,444.

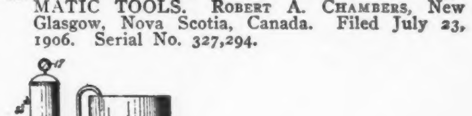
838,520. AIR-BRAKE. BENJAMIN CANELL, West Springfield, Mass. Filed July 10, 1906. Serial No. 325,438.

838,692. AUTOMATIC FUEL-VALVE. ALFRED W. DATER, Stamford, Conn. Filed Dec. 20, 1905. Serial No. 292,584.

838,887. PUMP. HENRY NAGEL and JOHN E. NAGEL, Brunswick, Neb. Filed May 13, 1905. Serial No. 260,276.

839,031 PNEUMATIC TOOL. HAROLD A. R. PRINDLE and JOHN U. ADOLPH, Philadelphia, Pa. Filed Oct. 10, 1904. Serial No. 227,896.

839,111. APPARATUS FOR TESTING PNEUMATIC TOOLS. ROBERT A. CHAMBERS, New Glasgow, Nova Scotia, Canada. Filed July 23, 1906. Serial No. 327,294.



Claim.—1. In a device of the class described, a cylinder, a piston therefor, adjustable means for introducing a column of water into said cylinder, a compressor-tank, means connecting said compressor-tank and cylinder, a reciprocating tool attached to said piston, and means for registering the impact of the piston against a column of water within the cylinder.

839,115. HUMIDIFYING DEVICE. CHARLES M. COLVIN, Wilmette, Ill., assignor of one-half to Sackett H. Verrall, Chicago, Ill. Filed May 17, 1906. Serial No. 317,297.

839,168. MACHINE FOR FORMING SHEET-GLASS. JOHN L. MALONEY, Bellaire Ohio, assignor of one-fifth to Thomas Moran, Bellaire, Ohio. Filed July 12, 1906. Serial No. 325,909.

839,186. AIR-BRAKE SYSTEM. JAY NOBLE, St. Louis, Mo. Filed July 10, 1905. Serial No. 268,997.

839,254. AUTOMATIC INKSTAND. FRANK M. ASHLEY, New York, N. Y., assignor of one-half to George D. Mumford and Henry Willard Bean and one-half to Albert T. Scharps, New York, N. Y. Filed Apr. 9, 1898. Serial No. 677,004.

839,255. CIRCUIT-OPENING DEVICE FOR ELECTRIC HEATERS. JAMES I. AYER, Cambridge, Mass., assignor to Simplex Electric Heating Company, Boston, Mass., a Corporation of Massachusetts. Filed May 5, 1905. Serial No. 258,922.

839,312. PRESSURE-BLOWER. CHRISTIAN NEUMANN, St. Louis, Mo. Filed Jan. 28, 1905. Serial No. 243,053.

839,327. SAFETY ELEVATOR AIR-BRAKE. FRED E. SMALL and THEODORE M. LATSCH, Los Angeles, Cal. Filed Apr. 24, 1906. Serial No. 313,371.

839,366. AIR-BRAKE SYSTEM. FRED B. COREY, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. Filed June 5, 1905. Serial No. 263,703.

839,586. ROCK-DRILL. HENRY HELLMAN and LEWIS C. BAYLES, Johannesburg, Transvaal. Filed May 31, 1904. Serial No. 210,519.

839,598. SAFETY DEVICE FOR AIR-BRAKES. JOSEPH JUDGE, Pittston, Pa. Filed Aug. 28, 1906. Serial No. 332,335.

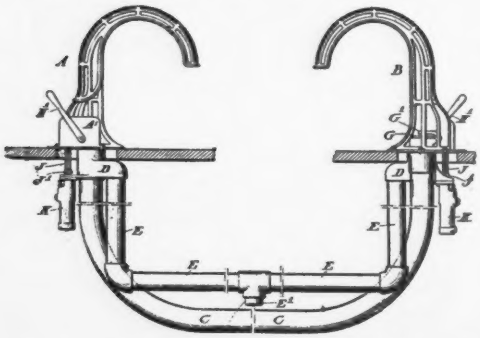
839,626. DEVICE FOR INFLATING THE PNEUMATIC TIRES OF VEHICLES. CARL NIELSEN, Copenhagen, Denmark. Filed Dec. 14, 1905. Serial No. 291,755.

839,727. HANDLE FOR PNEUMATIC HAMMERS. CHARLES T. CARNAHAN, Denver, Colo. Filed July 31, 1906. Serial No. 328,583.

839,769. AIR-BRAKE MECHANISM. ELMORE C. JORDAN and CHARLES B. BROWN, Los Angeles, Cal. Filed Feb. 20, 1906. Serial No. 302,114.

840,464. PNEUMATIC-TUBE SYSTEM. BIRNEY C. BATCHELLER, Philadelphia, Pa., assignor to The Pearsall Pneumatic Tube and Power Company, New York, N. Y., a Corporation of New York. Filed May 1, 1905. Serial No. 258,288.

840,465. PNEUMATIC-TUBE SYSTEM. BIRNEY C. BATCHELLER, Philadelphia, Pa., assignor to The Pearsall Pneumatic Tube and Power Company, New York, N. Y., a Corporation of New York. Filed May 1, 1905. Serial No. 258,289.



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840,499. SPEED-GOVERNOR. JOHN KNOWLSON, Troy, N. Y. Filed May 7, 1906. Serial No. 315,478.

840,530. AIR-FILTER. IRA F. WALLACE, Minneapolis, Minn., and WILLIAM L. KELLOGG, Sioux City, Iowa. Filed Oct. 11, 1901. Serial No. 78,288.

840,605. TRANSMISSION-GEAR. CHARLES H. BROOKS, Detroit, Mich., assignor to The Brooks Motor Company, Detroit, Mich., a Corporation of Michigan. Filed Mar. 30, 1906. Serial No. 308,858.

840,724. PNEUMATIC CLEANER AND SEPARATOR BERT E. SWEET, Lodi, Cal. Filed Dec. 28, 1905. Serial No. 293,646.

840,816. ROCK-DRILL. THOMAS E. ADAMS, Cleveland, Ohio, assignor to The Adams Drill Company, Cleveland, Ohio, a Corporation of Ohio. Filed Oct. 24, 1901. Serial No. 79,832

840,880. PNEUMATIC-DESPATCH APPARATUS. FRED R. TAISEY, Indianapolis, Ind., assignor to The Lamson Consolidated Store Service Company, Boston, Mass., a Corporation of New Jersey. Filed May 24, 1906. Serial No. 318,473.

841,001. SELF-CONTAINED ROCK-DRILL. OTHO C. DURYEA and MORRIS C. WHITE, Los Angeles, Cal., assignors to National Gas Drill Company, a Corporation of California. Filed Apr. 28, 1903. Serial No. 154,678.

841,069. PNEUMATIC DRILL. HARRY P. TAYLOR, Salt Lake City, Utah. Filed Apr. 28, 1905. Renewed July 14, 1906. Serial No. 326,277.

841,636. AUTOMATIC AIR-BRAKE FOR CARS. WILLIAM J. DANKEL, Pittsburg, Kan. Filed Mar. 24, 1906. Serial No. 307,812.

841,139. ROCK-DRILL. ARTHUR H. GIBSON, Easton, Pa., assignor to The Ingersoll-Sergeant Drill Company, New York, N. Y., a Corporation of West Vriginia. Filed July 28, 1905. Serial No. 271,602.

841,162. LUBRICATOR FOR PNEUMATIC ENGINES. WILFRED LEWIS, Philadelphia, Pa., assignor to Tabor Manufacturing Company, Philadelphia Pa., a Corporation of New Jersey, Filed Sept. 20, 1904 Serial No. 225,279.

841,231. AIR-BRAKE SYSTEM. FRED B. COREY, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. Filed May 25, 1906. Serial No. 318,883.

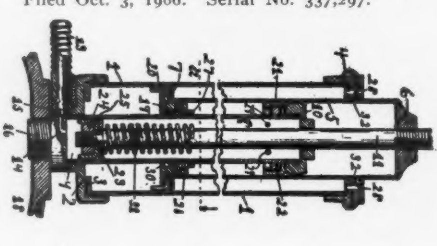
841,469. PRESSURE - CONTROLLING VALVE FOR AIR-BRAKE SYSTEMS. WALTER V. TURNER, Wilmerding, Pa., assignor, by direct and mesne assignments, to The Westinghouse Air Brake Company, Pittsburg, Pa., a Corporation of Pennsylvania. Filed July 6, 1903. Renewed Mar. 31, 1906. Serial No. 309,052.

841,751. AIR-BRAKE. HENRY H. WESTINGHOUSE, New York, N. Y., assignor to The Westinghouse Air-Brake Company, Pittsburg, Pa., a Corporation of Pennsylvania. Filed Oct. 6. 1904. Serial No. 227,374.

842,003. PRESSURE-ACTUATED VALVE FOR ENGINES. THOMAS OFFICER and HENRY H. MERCER, Claremont, N. H., assignors to Sullivan Machinery Company, Claremont, N. H., a Corporation of Maine. Filed Oct. 30, 1905. Serial No. 284,991.

842,136. METHOD OF TESTING PNEUMATIC TOOLS. ROBERT A. CHAMBERS, New Glasgow, Novia Scotia, Canada. Filed July 23, 1906. Serial No. 327,293.

842,142. PNEUMATIC PUMP. JACOB FUNCK, Rochester, N. Y., assignor to Judd & Leland Manufacturing Company, Clifton Springs, N. Y. Filed Oct. 3, 1906. Serial No. 337,297.



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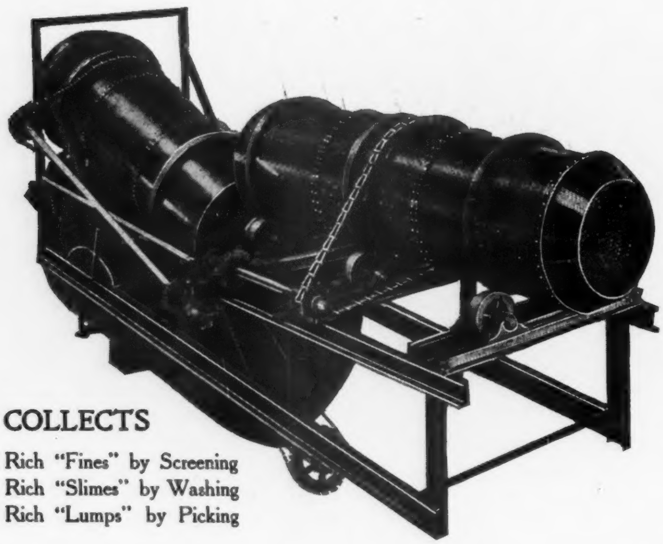

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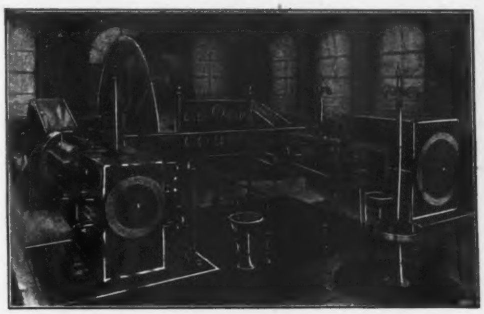

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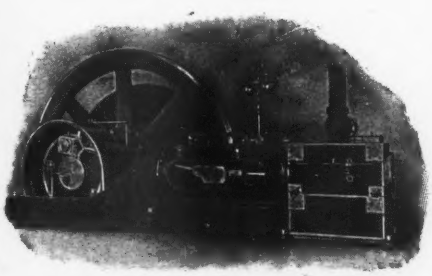

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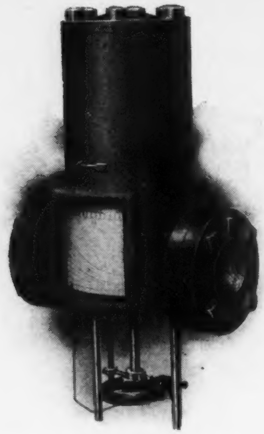

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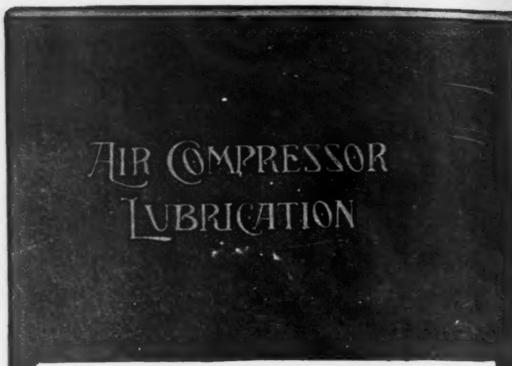

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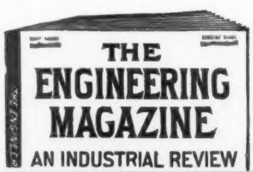

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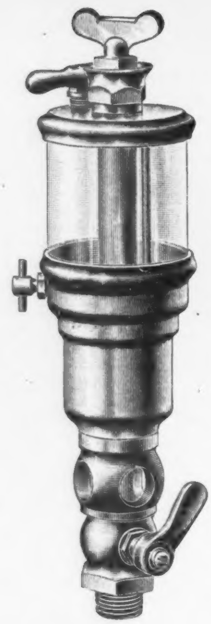

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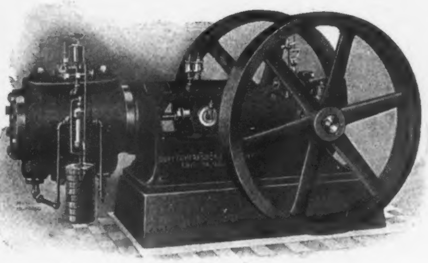

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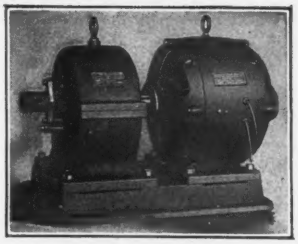

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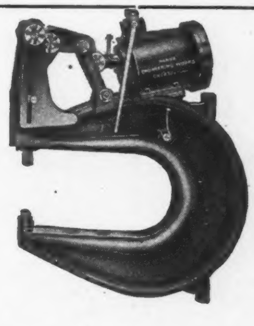

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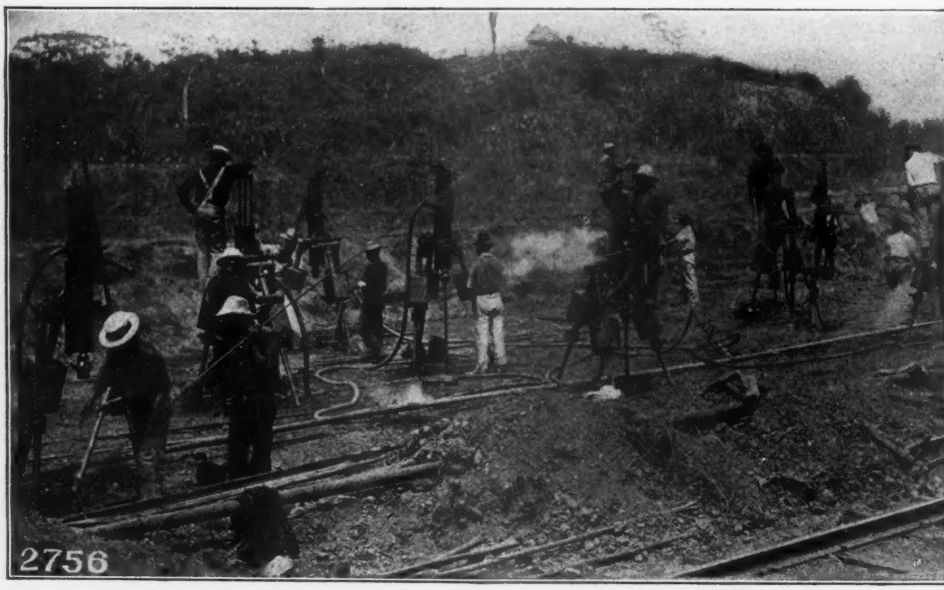

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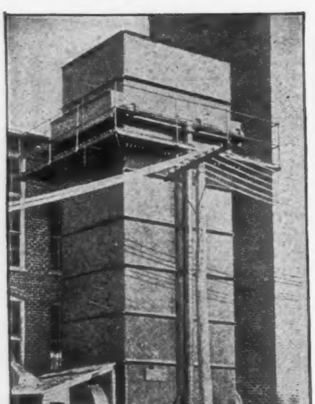

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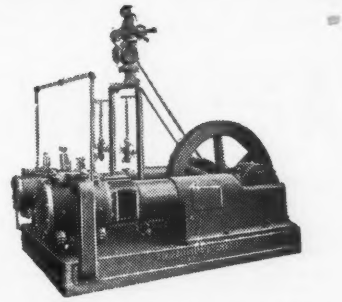

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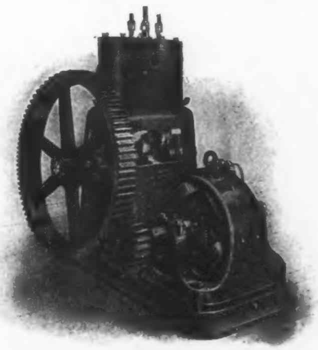

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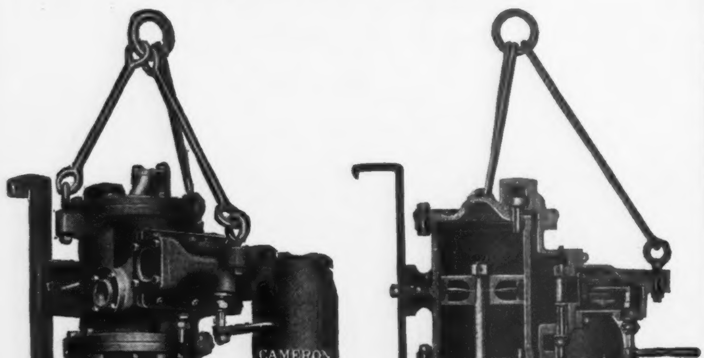

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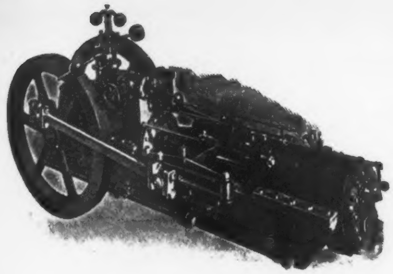

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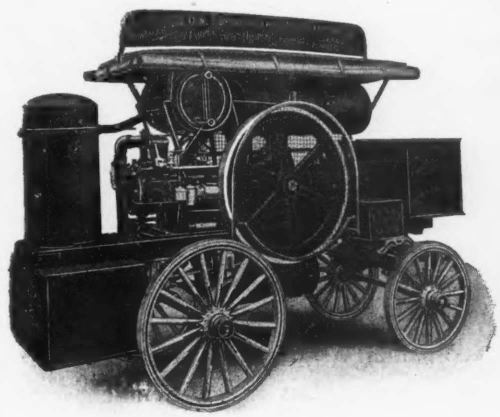

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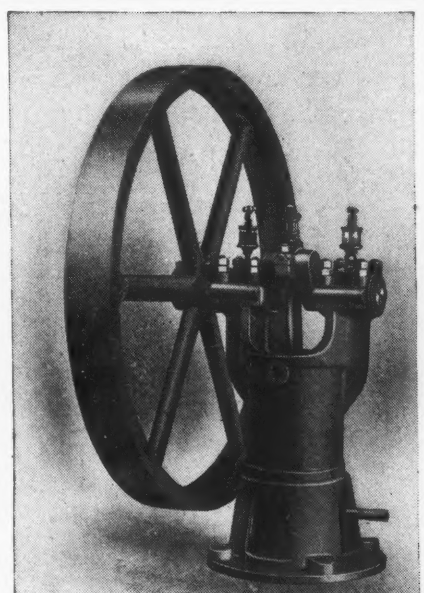

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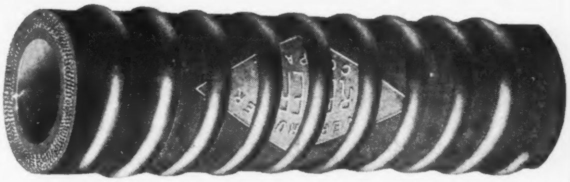

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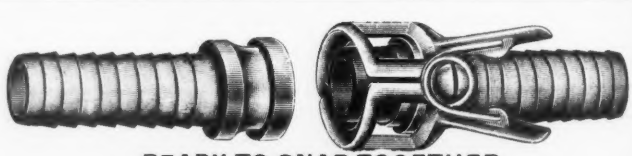

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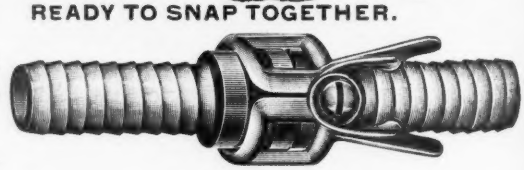

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